DRAFT
ENVIRONMENTAL IMPACT STATEMENT
APPENDICES

Village at Po'ipū

Prepared By:

PBR HAWAII

Prepared For:
Accepting Authority,
State of Hawai'i Land Use Commission
Docket No. A05-761
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Appendix A

BOTANICAL SURVEY
PO'IPULANI PROJECT
PO'IPU, KOLOA DISTRICT, KAUA'I

by

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INTRODUCTION

The Po'ipulani project site is bounded by the Po'ipu Road to the south, the Weliweli Houselots Subdivision and abandoned sugar cane fields to the east, Weliweli Road to the north, and Hapa Road and undeveloped scrub-covered lands to the west. Elevation ranges from about 30 ft. above mean sea level (msl) along the Po'ipu Road boundary to roughly 200 ft. above msl along the Weliweli Road (mauka) boundary.

The soils on the site are mapped as Waikomo very rocky silty clay, "Wt" on the soil maps (Foote et al. 1972). These are well-drained, dark grayish-brown colored, stony and rocky soils; rock outcrops may cover 3% to 25% of the surface. Topography is gently sloping. Permeability is moderate. Runoff is slow and the erosion hazard is slight. These soils are used for pasture, wildlife habitat, and homesites.

Most of the 206-acre Po'ipulani site is used for grazing cattle and horses, and supports pastureland scrub. Areas which are not grazed are covered by dense koa haole thickets.

On September 23 and 24, 2002, a botanical (flora) survey was conducted for the 206-acre Po'ipulani property owned by the Eric A. Knudsen Trust; the survey was conducted by a team of three botanists. The primary objectives of the field studies were to:

1) prepare a general description of the vegetation on the site.
2) inventory the flora;
3) search for threatened and endangered species as well as species of concern; and
4) identify areas of potential environmental problems or concerns and propose appropriate mitigation measures.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the survey team with other botanical studies conducted in the general area. A recent colored aerial photograph (1"=200') with the boundaries outlined and a topographic map were examined to identify vegetation cover patterns, terrain characteristics, access, boundaries, and reference points.

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

All of the property, including the smaller disjunct parcels, were easily accessed from Hapa Road. Stacey T.J. Wong from the Knudsen Trust accompanied the survey team on September 23 to point out fenceline boundaries and other reference points, and to provide background information on past land uses.

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 of the year and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual plants.

DESCRIPTION OF THE VEGETATION

An earlier botanical survey by Whistler (1990) covered parts of the Po'ipulani project site. This study was made in February 1990 during the rainy season. Two broad vegetation types or plant communities were recognized in that study: pastureland scrub and *Leucaena* scrub forest.

For this study, we also recognized the pastureland scrub vegetation type. Whistler's report (1990) did not include the smaller, disjunct parcels; these are covered by dense thickets of koa haole (*Leucaena leucocephala*).

An inventory of all the plants observed on the 206-acre project site during the field studies is presented in the species list at the end of this report.

Pastureland Scrub

Some sections along the west boundary were cultivated by the Koloa Sugar Company in the past, but soil conditions were poor. For the last 40 to 50 years, the property has been used for grazing cattle and horses (S. Wong, pers. comm.).

The general physiognomy of this vegetation type is open and grassy with scattered patches of shrubs and trees. Guinea grass

(Panicum maximum) and sourgrass (Digitaria insularis), 2 to 4 ft. tall, are the most abundant grasses. Other grasses which are common to occasional in this vegetation type are Bermuda grass or manienie (Cynodon dactylon), swollen fingergrass (Chloris barbata), and buffelgrass (Cenchrus ciliaris). A number of weedy herbaceous species are locally abundant to common within the pastureland scrub; these include false mallow (Malvastrum coromandelianum), lion's ear (Leonotis nepetifolia), spiny amaranth (Amaranthus spinosus), and golden crown-beard (Verbesina encelioides). Wild cucumber (Cucumis dipsaceus) vines covered with yellow, bristly, egg-shaped fruits are locally abundant in some places. Areas with rock outcrops and exposed, weathered pahoehoe substrate support sparser vegetation, primarily Natal redtop grass (Melinis repens), lovegrass (Eragrostis amabilis), air plant (Bryophyllum pinnatum), and Portulaca pilosa.

Koa haole shrubs occur as scattered individuals or scattered patches of plants. In some places, the koa haole shrubs are 3 to 5 ft. tall; these have been cut back so that the cattle can reach them for forage. In other places, especially along the south half of the property, the koa haole shrubs are taller, 6 to 12 ft. high, and somewhat denser, about 40% cover. Kolomona (Senna surattensis), a large shrub to small tree, and hedge cactus (Cereus uruguayanus), a large, spiny cactus which can reach 18 to 20 ft. in height, are commonly associated with the koa haole shrubs. The hedge cactus which has some nasty spines up to 2 inches long was reportedly introduced by the Moir family as an ornamental, but has since escaped cultivation and is now naturalized in dry areas on southern Kaua'i (Wagner et al. 1990). The moon cactus (Harrisia martinii), a many-branched, scandent or climbing cactus with numerous small spines, about one-quarter inch long, is locally abundant on rock outcrops and especially along the old railroad berm; this species was also originally introduced as an ornamental (Wagner et al. 1990). Both of these cacti make surveying difficult when they occur in large patches.

Other woody components which are scattered throughout the property include Java plum (Syzygium cumini), 'opiuma (Pithecellobium dulce), kiawe (Prosopis pallida), and Chinese banyan (Ficus microcarpa). The Chinese banyan trees are usually associated with rock outcrops. On the mauka half of the property, Java plum, Chinaberry (Melia azedarach), Chinese banyan, silk oak (Grevillea robusta), and Christmas berry (Schinus terebinthifolius) become somewhat more numerous; this may be due to a slight increase in the rainfall gradient. A few fruit trees, which include mango (Mangifera indica), pomegranate (Punica granatum), and tamarind (Tamarindus indicus), are found near a corral/stonewall area near the middle of the property.

Koa Haole Thicket

Koa haole thicket is found on the south end of the property where it borders Po'ipu Road and on the two smaller, disjunct parcels: the oddly-shaped parcel bordering Weliweli Road and the small parcel immediately north of the Catholic church and cemetary.

On the south end of the property, tall koa haole shrubs, 15 to 20 ft. high, form a more or less closed canopy. Taller, emergent kiawe trees, 25 to 30 ft. high, are scattered throughout the thicket or occur in small stands. Ground cover is patchy especially where the canopy cover is dense and consists of clumps of Guinea grass and sourgrass. Somewhat more shade-tolerant species are found here; these include coral berry (Rivina humilis), blue potato vine (Solanum seaforthianum), liliko'i (Passiflora edulis f. flavicarpa), and apple of Peru (Nicandra physalodes). Areas with solid rock outcrops are more open and support patches of hedge cactus and moon cactus. Whistler (1990) described this vegetation type as Leucaena scrub forest in his report.

On the two smaller parcels, the vegetation consists of koa haole shrubs, 10 to 15 ft. tall, with robust clumps of Guinea grass, 3 to 5 ft. tall, filling in the matrix between the shrubs; these two parcels are not grazed. On the parcel north of the church and cemetary, Mauritius hemp (Furcraea foetida) and coral berry are locally abundant. Mauritius hemp forms large, bright green, succulent rosettes up to 6 ft. tall and 6 to 8 ft. across.

On the northern-most parcel, Mauritius hemp is also locally abundant. Along the Weliweli Road boundary, be-still tree (Thevetia peruviana) is abundant. Bright yellow, tubular flowers and shiny foliage make it easy to identify in the field.

DISCUSSION AND RECOMMENDATIONS

The vegetation on the project site is dominated by introduced or alien species such as koa haole, Guinea grass, sourgrass, hedge cactus, Mauritius hemp, etc. A total of 83 plant species were inventoried on the site. Eighty (96%) of these species are introduced; introduced species are all those plants which were brought by humans, intentionally or accidentally, after Western contact, that is, Cook's arrival in the islands in 1778.

Three (4%) species are indigenous, that is, they are native to Hawai'i and other geographic areas. The indigenous species are 'ilima (*Sida fallax*), 'uhaloa (*Waltheria indica*), and kakalaioa (*Caesalpinia bonduc*).

In the earlier survey which included most of the Po'ipulani project site, Whistler (1990) found the three indigenous species mentioned above plus 'ilie'e (*Plumbago zeylanica*), koali 'awa (*Ipomoea indica*), popolo (*Solanum americanum*), and kupala (*Sicyos pachycarpus*). Of these plants, only the kupala is endemic, that is, it is native only to Hawai'i; the others are all indigenous.

None of the plants found during this study or recorded in the earlier study is a threatened and endangered species or a species of concern (U.S. Fish and Wildlife Service 1999a, 1999b; Wagner *et al*. 1999). All of the plants can be found in similar disturbed, lowland habitats throughout the Hawaiian Islands.

Given these findings, the proposed development of the 206-acre Po'ipulani project site is not expected to have a significant negative impact on the botanical resources.

Some portions of the project site may be set aside to preserve archaeological sites or cave/lava tube systems which harbor rare Hawaiian insects and arthropods. Landscaping with native plants is recommended for these areas. Easy to grow lowland species such as wiliwili (*Erythrina sandwicensis*), 'ilima, naio (*Myoporum sandwicense*), naupaka kahakai (*Scaevola sericea*), pohinahina (*Vitex rotundifolia*), etc. could be used. Botanists at the nearby National Tropical Botanical Garden (NTBG) at Lawai should be contacted for planting suggestions and, perhaps, for planting material.

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PLANT SPECIES LIST -- Po'ipulani Project, Kaua'i

The following checklist is an inventory of all the plants observed on the Po'ipulani project site. The plant names are arranged alphabetically by families within each of two groups: Dicots and Monocots. The nomenclature and taxonomy of the flowering plants follow Wagner et al. (1990) and Wagner and Herbst (1999). The few recent name changes follow those reported in the Hawaii Biological Survey series (Evenhuis and Eldredge, eds., 1999-2002).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   - I = indigenous = native to Hawai'i and also elsewhere.
   - I? = questionably indigenous = data not clear if dispersal to the islands is by natural or human-related mechanisms, but weight of evidence suggests probably natural.
   - X = introduced or alien = all those plants brought to Hawai'i by humans, intentionally or accidentally, after Western contact, that is, Cook's arrival in the islands in 1778.
4. Presence (+) or absence (-) of a species within each of two vegetation types recognized on the project site (see text for discussion):
   - p = Pastureland Scrub
   - k = Koa Haole Thicket

Scientific name	Common name	Status	Vegetation type p	Vegetation type k
FLOWERING PLANTS				
DICOTS				
AMARANTHACEAE (Amaranthus family)				
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X	+	-
Gomphrena celosioides Mart.	wild bozu	X	+	-
ANACARDIACEAE (Mango family)				
Mangifera indica L.	mango, manako	X	+	-
Schinus terebinthifolius Raddi	Christmas berry	X	+	+
APOCYNACEAE (Dogbane family)				
Catharanthus roseus (L.) G. Don	periwinkle	X	+	-
Thevetia peruviana (Pers.) K. Schum.	be-still tree	X	+	+
ARALIACEAE (Ginseng family)				
Schefflera actinophylla (Endl.) Harms	octopus tree, umbrella tree	X	+	-
ASTERACEAE (Daisy family)				
Bidens pilosa L.	Spanish needle, ki, ki nehe	X	+	-
Conyza bonariensis (L.) Cronq.	hairy horseweed, ilioha	X	+	-
Cyanthillium cinereum (L.) H. Rob.	little ironweed	X	+	-
Emilia fosbergii Nicolson	flora's paintbrush, pualele	X	+	-
Parthenium hysterophorus L.	false ragweed	X	+	-
Pluchea carolinensis (Jacq.) G. Don	sourbush, pluchea	X	+	+
Synedrella nodiflora (L.) Gaertn.	nodeweed	X	+	-
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	X	+	-
Xanthium strumarium var. canadense (Mill.) Torr. & A. Gray	cocklebur, kikania	X	+	-
BASELLACEAE (Basella family)				
Anredera cordifolia (Ten.) Steenis	Madeira vine, 'uala hupe	X	+	-

Scientific name	Common name	Status	Vegetation type p	Vegetation type k
CACTACEAE (Cactus family)				
Cereus uruguayanus Ritter ex R. Kiesling	hedge cactus	X	+	+
Harrisia bonplandii (Parmentier) Britton & Rose		X	-	+
Harrisia martinii (Labour.) Britton	moon cactus	X	+	+
Hylocereus undatus (Haw.) Britton & Rose	night-blooming cereus	X	+	+
Opuntia ficus-indica (L.) Mill.	panini, papipi	X	+	-
CLUSIACEAE (Mangosteen family)				
Clusia rosea Jacq.	autograph tree, copey, Scotch attorney	X	+	+
CONVOLVULACEAE (Morning glory family)				
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	+	+
CRASSULACEAE (Orpine family)				
Bryophyllum pinnatum (Lam.) Oken	air plant, 'oliwa ku kahakai	X	+	+
Bryophyllum tubiflorum (Harv.) Raym.-Hamet	chandelier plant	X	+	+
CUCURBITACEAE (Cucumber family)				
Cucumis dipsaceus Ehrenb. ex Spach	wild cucumber, hedgehog gourd, teasel gourd	X	+	-
EUPHORBIACEAE (Spurge family)				
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	+	-
Euphorbia tirucalli L.	pencil plant, milk hedge	X	-	+
Ricinus communis L.	castor bean, koli, pa'aila	X	+	-
FABACEAE (Pea family)				
Acacia farnesiana (L.) Willd.	klu	X	+	-
Caesalpinia bonduc (L.) Roxb.	kakalaioa, hikikolo	I	+	-
Crotalaria incana L.	fuzzy rattlepod, kukaehoki	X	+	-
Crotalaria pallida Aiton	smooth rattlepod, pikakani	X	+	-

Scientific name	Common name	Status	Vegetation type p	k
Desmanthus pernambucanus (L.) Thellung	slender mimosa	X	+	-
Indigofera suffruticosa Mill.	indigo, 'iniko	X	+	+
Leucaena leucocephala (Lam.) de Wit	koa haole, ekoa	X	+	+
Mimosa pudica var. unijuga L.	sensitive plant, sleeping grass, pua hilahila	X	+	-
Pithecellobium dulce (Roxb.) Benth.	'opiuma	X	+	+
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe	X	+	+
Samanea saman (Jacq.) Merr.	monkeypod	X	-	+
Senna occidentalis (L.) Link	coffee senna, 'auko'i	X	+	-
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona, kalamona	X	+	+
Tamarindus indica L.	tamarind	X	+	-
LAMIACEAE (Mint family)				
Leonotis nepetifolia (L.) R. Br.	lion's ear	X	+	-
MALVACEAE (Mallow family)				
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, ma'o	X	+	+
Malva parviflora L.	cheese weed	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	+	-
MELIACEAE (Mahogany family)				
Melia azedarach L.	Chinaberry, pride-of-India, 'inia	X	+	+
MORACEAE (Mulberry family)				
Ficus microcarpa L.f.	Chinese banyan	X	+	+
MYRTACEAE (Myrtle family)				
Psidium guajava L.	guava, kuawa	X	-	+
Syzygium cumini (L.) Skeels	Java plum	X	+	+

Scientific name	Common name	Status	Vegetation type p	Vegetation type k
NYCTAGINACEAE (Four-o'clock family)				
Boerhavia coccinea Mill.		X	+	-
PASSIFLORACEAE (Passion flower family)				
Passiflora edulis forma flavicarpa Degener	passion fruit, liliko'i	X	-	+
PHYTOLACCACEAE (Pokeweed family)				
Rivina humilis L.	coral berry	X	-	+
PORTULACACEAE (Purslane family)				
Portulaca oleracea L.	pigweed, 'akulikuli kula	X	+	-
Portulaca pilosa L.		X	+	-
PROTEACEAE (Protea family)				
Grevillea robusta A. Cunn. ex R. Br.	silk oak, 'oka kilika	X	+	-
PUNICACEAE (Pomegranate family)				
Punica granatum L.	pomegranate, pomelaiki	X	+	-
RUTACEAE (Citrus family)				
Murraya paniculata (L.) Jack	mock orange	X	+	+
SOLANACEAE (Nightshade family)				
Nicandra physalodes (L.) Gaertn.	apple of Peru	X	-	+
Solanum lycopersicon var. cerasiforme (Dunal) Spooner, Anderson, & Jansen	currant tomato, wild tomato	X	+	-
Solanum seaforthianum Andr.	blue potato vine	X	+	+
STERCULIACEAE (Cacao family)				
Waltheria indica L.	'uhaloa, hi'aloa, kanakaloa	I?	+	+
VERBENACEAE (Verbena family)				
Lantana camara L.	lantana, lakana	X	+	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi, oi	X	+	-

Scientific name	Common name	Status	Vegetation type p	Vegetation type k
MONOCOTS				
AGAVACEAE (Agave family)				
Agave sisalana Perrine	sisal, malina	X	+	-
Furcraea foetida (L.) Haw.	Mauritius hemp	X	+	+
Sansevieria trifasciata Prain	snake plant, mother-in-law's tongue	X	-	+
COMMELINACEAE (Spiderwort family)				
Commelina benghalensis L.	hairy honohono	X	+	-
POACEAE (Grass family)				
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	+	-
Cenchrus ciliaris L.	buffelgrass	X	+	+
Chloris barbata (L.) Sw.	swollen fingergrass	X	+	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	+	-
Digitaria ciliaris (Retz.) Koeler	crabgrass	X	+	-
Digitaria insularis (L.) Mez ex Ekman	sourgrass	X	+	+
Eragrostis amabilis (L.) Wight & Arnott	lovegrass	X	+	-
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X	+	-
Panicum maximum Jacq.	Guinea grass	X	+	+

Appendix B

REPORT OF FINDINGS FROM AN AVIFAUNAL AND FERAL MAMMAL FIELD SURVEY OF KNUDSEN TRUST PROPERTY AT POIPU, KAUAI

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INTRODUCTION

The purpose of this report is to provide the findings of a two day (5,6 October 2002) field survey of the birds and mammals found on and near a 206 acre Knudsen Trust site located at Poipu, Kauai. For comparative purposes this report also presents data from an earlier faunal survey (Bruner 1990a) of this property. In addition pertinent published and unpublished sources of information on the fauna of this region are also noted to support the results of the field survey. The goals of the field survey were:

1- To document what species of birds and mammals currently occur on and near the property.
2- Note natural resources important to native and migratory species.

SITE DESCRIPTION

This 206 acre property is covered in second growth introduced plants. Brush and grazed pasture habitat dominate the landscape. Residential property adjoins some of the site. No wetland habitat was found although some low spots might hold rain water for a short time after significant and prolonged storms. During the time of the survey the property was very dry and dusty. Some cattle and horses were grazing in a portion of the site.

SURVEY PROTOCOL

The property was surveyed on foot by following existing roads and trails that surround and traverse the site. All species of birds seen or heard were noted and relative abundance estimates (Table One) were obtained from eight minute circular plot counts made at scattered locations across the entire property. Data from the circular plot counts were taken from dawn to 1000 hours and 1600-1800 hours, peak activity periods for birds. Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain relative abundance estimates. Such an effort was beyond the scope and time allotted for this survey. One evening was devoted to searching for the presence of owls and the Endangered Hawaiian Hoary Bat (*Lasiuru cinereus semotus*). A. Pettersson Elektronik AB Ultrasound Detector D 100 was used to listen for foraging bats. The entire perimeter of the property and several interior locations were searched using the ultrasound detector on the evening of 5 October.

The weather during the survey period was partly cloudy in the mornings and evenings but generally clear at mid-day. Winds were 10-20 mph from the ENE. Conditions for detecting birds were excellent.

Scientific names used in this report follow Pyle (2002) and Honacki et al. (1982).

RESULTS AND DISCUSSION

NATIVE BIRD OBSERVATIONS:

The only native species recorded on the survey was the Hawaiian Owl or Pueo (*Asio flammeus sandwichensis*). Two Pueo (possible pair?) were seen foraging over the property on 5 October. A single Pueo was subsequently seen on a fence post across from the Catholic Church at the north end of the property on 6 October. This bird may have been one of the two seen the previous day. Pueo forage at dawn and dusk and may even be seen at mid-day. They utilize a variety of habitats including forests and agricultural lands but are most common in grasslands. Pueo feed on rodents, insects and occasionally birds. They nest on the ground in areas of relatively high grass (Pratt et al. 1987, Hawaii Audubon Society 1993, Denny 1999). This species is listed by the State of Hawaii as Endangered on the island of Oahu but not elsewhere in the State. No Pueo were noted on an earlier survey of this site (Bruner 1990a). Nene or Hawaiian Goose (*Branta sandvicensis*) were reintroduced to Kauai in the 1990's. A population established at Kipu Kai have been reported at Poipu (DLNR 1999-2000). None were seen on this faunal survey but they potentially could forage in the pasture lands at this site. The Nene is an Endangered species. The Kauai population is doing better than those on Maui and the Big Island. This is probably due in part to the absence of the Small Indian Mongoose (*Herpestes auropunctatus*) on Kauai.

No seabirds were recorded on the survey. The Newell shearwater (*Puffinus auricularis newelli*), a Threatened species, nests in the mountains of Kauai and may cross over this property when flying from its nest burrows to the sea where it forages. When the young birds leave the burrow and make their first trip out to sea they sometimes are attracted to urban lights and may strike power lines and fall on highways. Hawaii Audubon Society (1993) notes that a joint effort between state and federal biologists and Kauai residents rescue "nearly 2000 such birds annually". Shields designed to direct the light downwards are being used on street lights to address the problem. Denny (1999) points out that despite these efforts the Newell shearwater population continues to decline. Feral cats and rats take chicks and eggs which further complicates the problems this ground nesting species faces.

MIGRATORY BIRD OBSERVATIONS:

The only migratory bird recorded on the survey was the Pacific Golden-Plover or Kolea (*Pluvialis fulva*). This is the most common migratory shorebird wintering in Hawaii. They arrive from their breeding grounds in the arctic in August and most establish foraging territories which they actively defend until they depart back to the arctic in late April. Much research has been done on this species (Johnson et al. 1981, 1989, 1993, 2001a, 2001b). A total of 12 plover were tallied on the survey. These birds were all seen in the short grass patches and along the dirt roads on the property. Twelve years earlier 32 plover were tallied on this property over a similar two day field survey (Bruner 1990a). The only other migratory shorebird that might be seen in the same habitat as the Kolea is the Ruddy Turnstone or Akekeke (*Arenaria interpres*). This species is not territorial on the wintering grounds but generally forages in small flocks on shorelines, mudflats, fields and lawns. None of these migrants are listed as Threatened or Endangered.

INTRODUCED BIRDS:

A total of 20 species of introduced birds were recorded on the survey. Table One gives the names of these species and information on their relative abundance. An earlier survey of this property (Bruner 1990a) found 17 of these species. The three new species located on this 2002 survey were Sky Lark (*Alauda arvensis*) African Silverbill (*Lonchura cantans*), and Barn Owl (*Tyto alba*). The White-rumped Shama (*Copsychus malabaricus*) was not found on this 2002 survey but was present in 1990. The relative abundance estimates for both the 1990 survey and this 2002 survey are given in Table One for comparative purposes. None of the introduced birds are Threatened or Endangered. Other possible introduced birds that occur in this type of habitat on Kauai, but were not tallied on the 1990 or the 2002 survey are: *Rock* Dove (*Columba livia*), Rose-ringed Parakeet (*Psittacula krameri*), Japanese Bush-warbler (*Cettia diphone*), and Red Avadavat (*Amandava amandava*).

FERAL MAMMALS:

Seven feral cats (*Felis catus*) were seen over the course of the survey. Most were observed on the evening of 5 October. Rats (*Rattus rattus* ?) were seen running across Hapa road on the same evening. Despite a wide spread search from 1800 hours to 2200 hours no Hawaiian Hoary Bats were detected using the Ultrasound Detector nor were there any visual observations of bats. This endangered species is widespread on Kauai. The earlier (Bruner 1990a) survey likewise did not find bats. Never-the-less it is possible that the Hawaiian Hoary Bat may on occasion forage and even roost on this site. They are not restricted to native forest but can be seen in urban areas and over bays and ponds (Kepler and Scott 1990, Tomich 1986).

CONCLUSIONS

This survey examined the entire site and benefited from observations obtained on a 1990 survey. It was interesting to note how little change has occurred in the bird and mammal composition at this site in the past 12 years. No Endangered or Threatened species were found on either survey. A change in the landscape following development will likely increase the relative abundance of some introduced birds which prefer residential and urban habitat and decrease the numbers of those species that are more restricted to second growth forest and pasture lands. These shifts in the local populations of introduced birds will not significantly change the abundance of these species on Kauai. The native Hawaiian Owl will be less likely to utilize this area when it becomes urbanized. The migratory Pacific Golden-Plover population will be positively impacted if more of the site is turned into large lawns. Currently the plover population is limited by a shortage of short grass patches in which to forage. Much of the property is covered in grass that is too tall or brush that is too thick for foraging plover.

The man altered habitats at this location are not unique. Properties with similar resources are located nearby. Following urbanization the endangered Hawaiian Hoary Bat may frequent the site to forage around lighted areas as they have been seen doing elsewhere on Kauai (pers. observations).

TABLE 1

Introduced birds recorded in 1990 and 2002 on the Knudsen Trust property at Poipu, Kauai. Relative abundance (RA)estimates are based on eight minute circular plot counts and observations made on walking surveys. A=abundant (ave. 10+ on an eight minute count), C=common (ave. 5-10 on an eight minute count), U=uncommon (ave. less than 5 on an eight minute count), R=recorded (seen or heard at times other than on eight minute counts, number which follows is the total number seen or heard over the duration of the survey). Birds not on 1990 survey indicated by *. Species not on 2002 survey but present in 1990 marked by a #.

Common Name	Scientific Name	R A (1990)	R A (2002)
Cattle Egret	*Bubulcus ibis*	C = 8	U = 4
Red Junglefowl	*Gallus gallus*	C = 6	C = 8
Ring-necked Pheasant	*Phasianus colchicus*	C = 6	U = 2
Spotted Dove	*Streptopelia chinensis*	C = 7	A =12
Zebra Dove	*Geopelia striata*	A =12	A = 14
Barn Owl*	*Tyto alba*	---------	R = 2
Sky Lark*	*Alauda arvensis*	---------	U = 2
White-rumped Shama #	*Copsychus malabaricus*	U = 4	-------
Hwamei	*Garrulax canorus*	R = 6	R = 3
Japanese White-eye	*Zosterops japonicus*	A =10	A =13
Northern Mockingbird	*Mimus polyglottos*	A =10	R = 2
Common Myna	*Acridotheres tristis*	U = 4	C = 6
Red-crested Cardinal	*Paroaria coronata*	C = 5	U = 4
Northern Cardinal	*Cardinalis cardinalis*	C = 6	C = 8
Western Meadowlark	*Sturnella neglecta*	A =14	U = 3
House Finch	*Carpodacus mexicanus*	A = 12	C =10
House Sparrow	*Passer domesticus*	R = 2	U = 3
African Silverbill*	*Lonchura cantans*	-------	R = 9
Nutmeg Mannikin	*Lonchura punctulata*	R =13	C = 6
Chestnut Munia	*Lonchura atricapilla*	R =31	C = 5
Java Sparrow*	*Padda oryzivora*	---------	R =12

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Appendix C

Kauai

JOHN WAIHEE
GOVERNOR OF HAWAII

minor revisions

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

April 8, 1991

Hallett Hammatt, Ph.D.
Cultural Surveys Hawaii
49 South Kalaheo Avenue
Kailua, Hawaii 96734

Dear Dr. Hammatt:

SUBJECT: Historic Preservation Review -- Second Draft Archaeological Inventory Survey of the Proposed Po'ipulani Golf Course and Residential Development of the Po'ipulani Development, Koloa, Kaua'i (Hammatt, et. al. CSH 1991)
TMK: 2-8-13: por. 1 and 2-8-14: por. 1, 3, 19
Poipu, Koloa, Kauai

We have reviewed the second draft survey report for the proposed Poipulani Development. Except for some minor revisions and questions, the inventory survey report has been revised to document the sites fully. It is an acceptable inventory survey report. We appreciate your efforts and work to revise the report.

We have the following comments:

1. Page 29: Are you sure the last paragraph is correct? We think you mean that these two heiau are the only documented sites which correspond to both oral and written records and have survived any destruction. There may be other heiau or major religious structures that survive but have not been recorded. Also, Kiha-Houna heiau has been rebuilt, so in a sense it is more than "surviving."

1944

2. Page 53: You reference your site numbers for 49 A & B. Please use their correct state numbers.

3. Page 102: Site 950 was originally labelled a habitation site. Now you list it as an animal pen. Can you please tell us why the interpretation has changed?

Once the above points have been addressed with our staff, we can conclude that the project area has been adequately surveyed and that all historic sites have been likely found, totalling 75 sites. Based on your findings:

1. 12 sites are considered to be "no longer significant" because adequate amounts of their significant information were recorded during the survey.

2. 63 sites are still considered significant.

If you have any questions regarding this review, please contact Ms. McMahon at 587-0006.

Sincerely,

DON HIBBARD, Administrator
State Historic Preservation Division

cc: Loren Baxter
Peter Nakamura, Planning Department

ARCHAEOLOGICAL INVENTORY SURVEY OF THE PROPOSED PO'IPULANI GOLF COURSE AND RESIDENTIAL DEVELOPMENT KŌLOA, KAUA'I

by

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

prepared for

Po'ipulani Development Corporation

by
Cultural Surveys Hawaii
September, 1990
Revised January 1991
Revised July 1991

ABSTRACT

An archaeological inventory survey was conducted on 160 acres of land in the makai eastern portion of Kōloa along the Kōloa-Weliweli boundary (TMK 2-8-13 por.1; 2-8-14 por.1, 3, 19). A total of 75 archaeological sites were located, mapped, described and evaluated. Portions of the makai section of the project area were previously surveyed in 1978 and again in 1985. Although there has been considerable historic modification of the landscape for sugar cultivation and cattle ranching, significant remnants of a once continuous prehistoric habitation/agricultural complex remain on the property. Three or four of these complexes are well preserved and include walls, terraces, 'auwai and habitation structures. There are 2 caves on the property. The larger example is a lava tube over 300' (91 m.) long at the northern portion of the study area. Both caves have cultural layers and probable human burials. There are a total of 8 potential burial sites on the property and a number of historic sites including the sugar train berm. Preservation of major sites including all burial sites is recommended. All other sites which cannot be incorporated into the development should be subjected to a program of data recovery including subsurface testing and excavation.

ACKNOWLEDGEMENTS

Messrs. William Folk, Don Hugo, Jared Hammatt, Aron Suzuki and Chris Bailey with the authors performed fieldwork for this project. Mr. Lambert Kaiminaauao of Luna Nui Services provided valuable support and background information. Mr. Loren Baxter of Po'ipulani Development Corp. provided maps, copies of relevant documents related to the property and other general support. Location of the flagged points was performed by Portugal and Associates' surveyors Nathan Millare and Charles Brown. Drafting was performed by Mr. Steve Clark and Ms. Zoë Hammatt. Typing was done by Dr. Vicki Creed of Windword Processing.

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I. INTRODUCTION AND SCOPE OF WORK

This report presents the results of an inventory survey of 160 acres of land in Kōloa, Kaua'i (Figs. 1-4) proposed for golf course and residential development (TMK 2-9-13 por 1; 2-8-14 por. 1, 3, 19). Field work was conducted during June and July of 1990 and involved a total of 10 days with 3-5 archaeologists. The purpose of the work was to identify, describe and locate all archaeological sites on the property and to make recommendations for mitigation based on significance assessments of sites. The makai, east portion of the property had been surveyed by ARCH in 1978 (Hammatt et al, 1978) and portions were surveyed again in 1985 by Cultural Surveys Hawaii for a proposed Kōloa-Po'ipu Bypass Road (Hammatt et al., 1985). The area north (mauka) of the railroad berm had never been systematically surveyed.

Vegetation consisted predominantly of koa haole (Leucaena glauca) with scattered mature opiuma (pithecellobium dulce) and kiawe (Prosopis pallida). Except in the thick stands of koa haole in unbulldozed area, visibility during field work was generally excellent because of seasonal dry conditions and the ongoing use of the project area for cattle grazing. Thick stands of koa haole were encountered generally in rocky areas in the south, southeast and east central portions of the project area. The first task of field work was to identify and flag sites. This was accomplished by east/west sweeps proceeding makai to mauka with archaeologists spaced 50-75 feet apart depending on vegetative thickness. The survey ground coverage was accom-

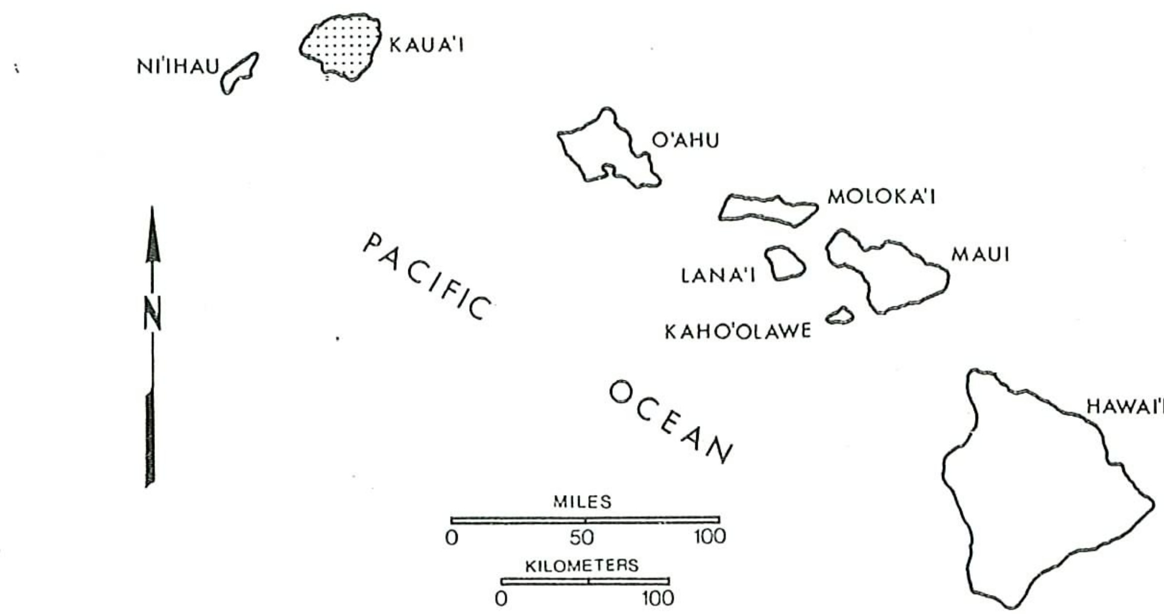

Fig. 1 State of Hawai'i

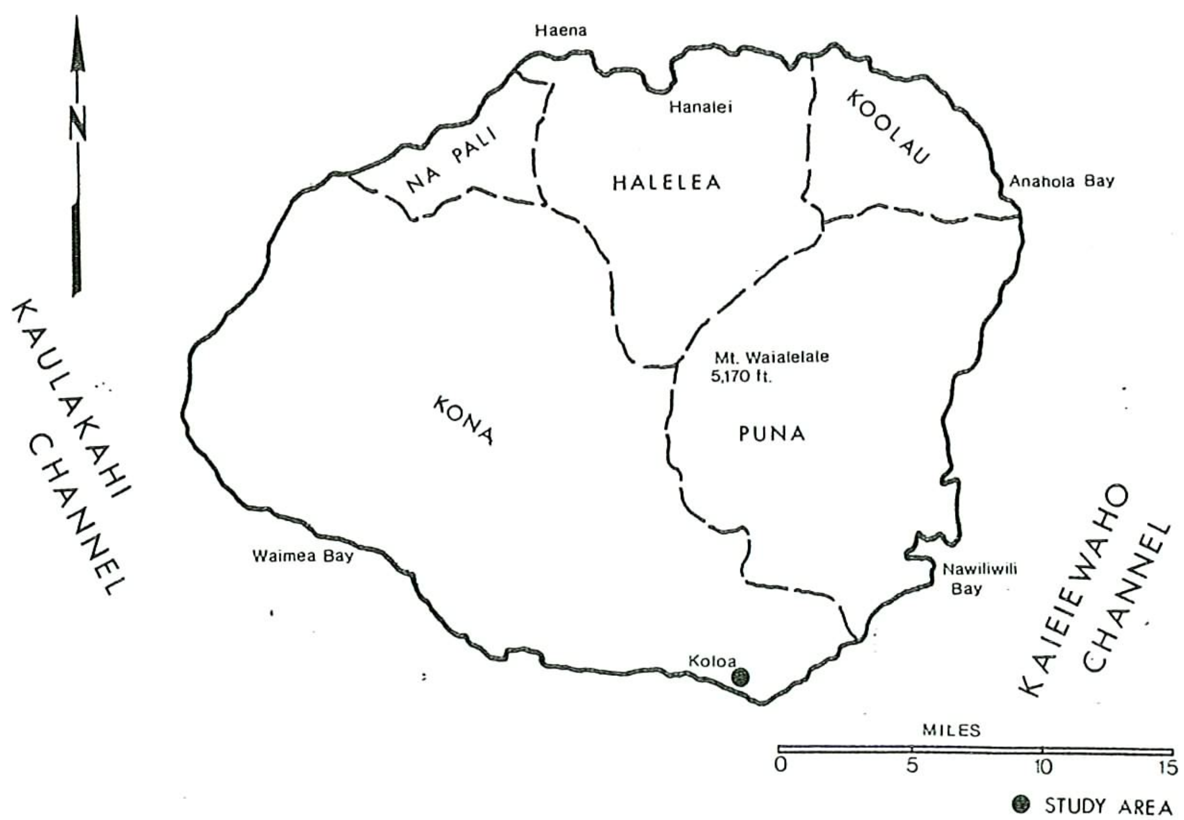

Fig. 2 Island of Kaua'i, Location Map

Fig. 3 U.S.G.S. Map of Kōloa Quad, Showing Project Area

plished in 20 east/west sweeps with 3-4 archaeologists, averaging 4-6 sweeps per day. Each site was flagged and labeled with yellow construction tape. Longer site complexes and walls were marked with 2 or more flagged points. These marked points were located on the 1 inch = 200 foot map by the Portugal and Associates survey team. The archaeologists then returned to the sites to describe them and prepare scale maps of individual sites. Most sites were sketched and mapped in plan view to scale but only selected maps are included in this report. All of these are in field notes kept at Cultural Surveys Hawaii lab.

There are numerous low rock mounds on the property which are the result of modern land clearing for sugar planting or grazing and younger than 50 years in age. In general, these were noted but not inventoried unless they were sizeable or contained facings or internal features which may indicate their possible pre-historic age or use for purposes other than stone clearance. All major field and cattle walls were mapped but there are some short collapsed wall sections in bulldozed areas which were not placed on the map. These were generally all but destroyed and were recognizable only as linear stone piles. The wide-spread occurrence of these remnants indicates that all land within the project area except rocky bluffs was prehistorically used for irrigated agriculture and even rocky lands were modified for dryland planting. Today, however, after extensive impact from land clearing for sugar cultivation and grazing only isolated remnants of this former landscape survive. This fact is evidenced by the isolated occurrence of archaeological sites within the project area as shown on Fig. 4. The spatial patterning of sites is not a pre-historic land use pattern but a function of selective clearing for sugar planting and grazing which generally avoided rocky or uneven terrain. Sites remain intact only in these rocky or uneven areas.

All archaeological sites are located on the project area map (Fig. 4 in back pocket) and a list of sites with significance assessments is presented in Table 1.

II. HISTORIC BACKGROUND

The project area is located within the Ahupua'a of Kōloa, in the Kona district of Kaua'i. Kōloa is a relatively large ahupua'a (ca. 9,500 acres) and is bounded on the west by Lāwa'i and on the east by Weliweli Ahupua'a(s). The derivatives for the place name Kōloa include: "Kō-loa, the large, soft, Hawaiian sugar cane (S. officinarum) once found in the area;" Kōloa, "on the east bank of Waikomo Stream in Kōloa town there is a steep rock from which the district takes its name. The bank was called Pali o-Kōloa; Kōloa, after the native Hawaiian duck (Anas wyvilliana)" (Kikuchi, 1963: 46 and Pukui et al. 1974:116).

Early historical and ethnographic information suggests that Kōloa was well populated during late prehistoric time. The earliest explorers, like Cook and Vancouver, used Waimea for anchorage and victualizing, with no mention made of Kōloa. However, their descriptions of well maintained, watered agricultural systems, on this dry Leeward coast, are echoed in the early descriptions of Kōloa.

Cook states: "What we saw of their agriculture, furnished sufficient proofs that they are not novices in that art. The vale ground has already been mentioned as one continuous plantation of taro, and a few other things, which all have the appearance of being well attended to" (Cook, 1784). Vancouver's description, in part, states: "...the low country which stretches from the foot of the mountains toward the sea, occupied principally with the taro plant, ...interspersed with some sugar-canes of luxuriant growth and some sweet potatoes" (Vancouver, 1798).

In 1835 two American naturalists, Thomas Nuttall and John K. Townsend, visited the Kōloa area with Townsend noting "fields of taro, yam, and maize(? probably sugar cane), irrigation networks and sweet potato patches in the dryer areas" (Townsend, 1839:206). Also in the 1830s J.J. Jarves, in "Sketches of Kauai", remarked on the fields of sugar cane, taro, and yams which indicated a more than usual attention to agriculture.

The extensive agricultural fields and their well maintained appearance indicate a relatively well populated area. Bernice Judd in "Kōloa: A sketch of its Development" (1935) suggests that prior to European contact the population of Kōloa must have been several thousand. The first missionary census (1833) accounted for a population of 2,166 for "Kōloa," but "Kōloa" referred to the area between Wahiawa and Kalapaki.

Other evidence indicating the importance of the Kōloa area during prehistorical time includes a relatively large number of heiau. The Lahainaluna schools listed 14 heiau and 1 fishing shrine for Kōloa. Of the 14 heiau at least 3 were Luakini class, 2 were po'okanaka, 5 associated with fishing, 2 medicinal, 1 agricultural, with 4 of unknown function (Lahainaluna 1885 HMS 43 #17).

The first missionary (Protestant Mission ABCFM) stationed at Kōloa was the Rev. Peter Gulick who moved from the Waimea Station in 1834. In 1835 a grass house some 30' by 60' (9.1 by

18.3 m.) was erected as the meeting house and school. Gulick also initiated sugar cane cultivation and a cattle herd for the Protestant Mission. In 1837 an adobe church was built and the first mission doctor, Dr. La Fon, arrived. Dr. La Fon moved to Lihue in 1840 and was replaced by Dr. J. W. Smith in 1842. Dr. Smith as both doctor and missionary could not continue the farming activities started by the Rev. Gulick and reduced the cattle herd and sent to Honolulu 7,000 lbs. of sugar which were produced from cane grown on mission lands (Stauder, 1973:22). At the time of the Mahele (ca. 1850) the ABCFM (Protestant Mission) received about 825 acres in Kōloa, some near Prince Kuhio Park and the bulk around Kōloa Town.

<u>Sugar</u>

The Kōloa area is the site of the oldest sugar plantation in Hawai'i. In 1835 Ladd and Company gained the lease of some one thousand acres at Kōloa for the purpose of growing sugar cane. "The lease allowed the use of the waterfall and an adjoining mill site at Maulili Pool, the right to build roads, and the privilege of unrestricted buying and selling, and freedom from local harbor dues" (Stauder, 1973:18; from Judd, 1935). Ladd and Company were not the first to mill sugar cane in the area, as there was a Chinese-operated granite roller mill in operation at Māhā'ulepū, Kōloa in 1830. Ladd and Company were, however, the first "plantation" organized industry in Hawai'i. Along with the lease the company was allowed to "hire native workers provided they paid the king, Kamehameha III, and Kaikioewa, appointed Governor of Kaua'i, a tax for each man employed and paid the men satisfactory wages" (Ibid.:18). The plantation set up houses for native workers and a store where the employees could purchase merchandise with the plantation currency in which they were paid. The cane growing activity of Ladd and Co. was not done directly on the project property, but the commercial activity initiated by the plantation had wide spread ramifications. Kōloa Town and the landing at the mouth of Waikomo Stream became major commercial centers. The landing, or "roadstead" as it was called, was a busy port during the mid 1800s. "An estimate in 1857 stated that 10,000 barrels of sweet potatoes were grown each year at Kōloa, and that the crop furnished nearly all the potatoes sent to California from Hawai'i. Sugar and molasses were also chief articles of export" (Judd, 1935:326). Whalers also used the "Kōloa Roadstead" during this era (1830-1870) and took on provisions of squashes, salt, salt beef, pigs, and cattle. Hawaiians grew the squashes (pumpkins) on the rocky lands north of the landing and numerous salt pans were located along the shore near the landing (Stauder, 1973:20).

Ladd and Company actually went bankrupt in 1845 but incorporated in 1880 (Kōloa Sugar Co.) following a succession of individual and partnership owners. In 1948 the Kōloa Sugar Company became part of the Grove Farm Company.

Sugar cane cultivation was not initiated on a large scale until the 1880s and 1890s. A 1891 map by M.D. Monsarrat (Fig. 5) shows that the project area was not yet in cane cultivation. This changed with the advent of McBryde Sugar Company in the late 1890s. Benjamin F. Dillingham incorporated "three estates, namely Kōloa Agricultural Co. (no connection with Kōloa Sugar Co.), Eleele Plantation, and Wahiawa Ranch" (Condé and Best, 1973:191). Theo. H. Davies was the acting agent until 1909 when Alexander and Baldwin took over agency control.

Expansion of cane fields and rail lines was rapid, as by 1903 rail lines had been completed to their Kōloa Fields and Kōloa Landing. The manager's report of 1904 states: "Our permanent railroad had been graded into Kōloa Village.... A span has also been run down from the main track to the coral sand beach between Kukuiula and Kōloa Landing, so that we are able to load sand as required for fertilizer and other uses ...." (Ibid.:191). A 1918 map of Kōloa Sugar Co. (Fig. 6) shows field 4A as the only cane land intruding into the project area. This field probably corresponds to Site 938. The 1918 map does not show the railroad berm traversing the property.

Mahele Records

The bulk of the ahupua'a of Kōloa at the time (ca. 1850) of the "Great Mahele," went to Moses Kekuaiwa (LCA 7714-B). The award covered some 8,620 acres for "West Kōloa," which refers to the actual ahupua'a of Kōloa, as Kōloa was also the district

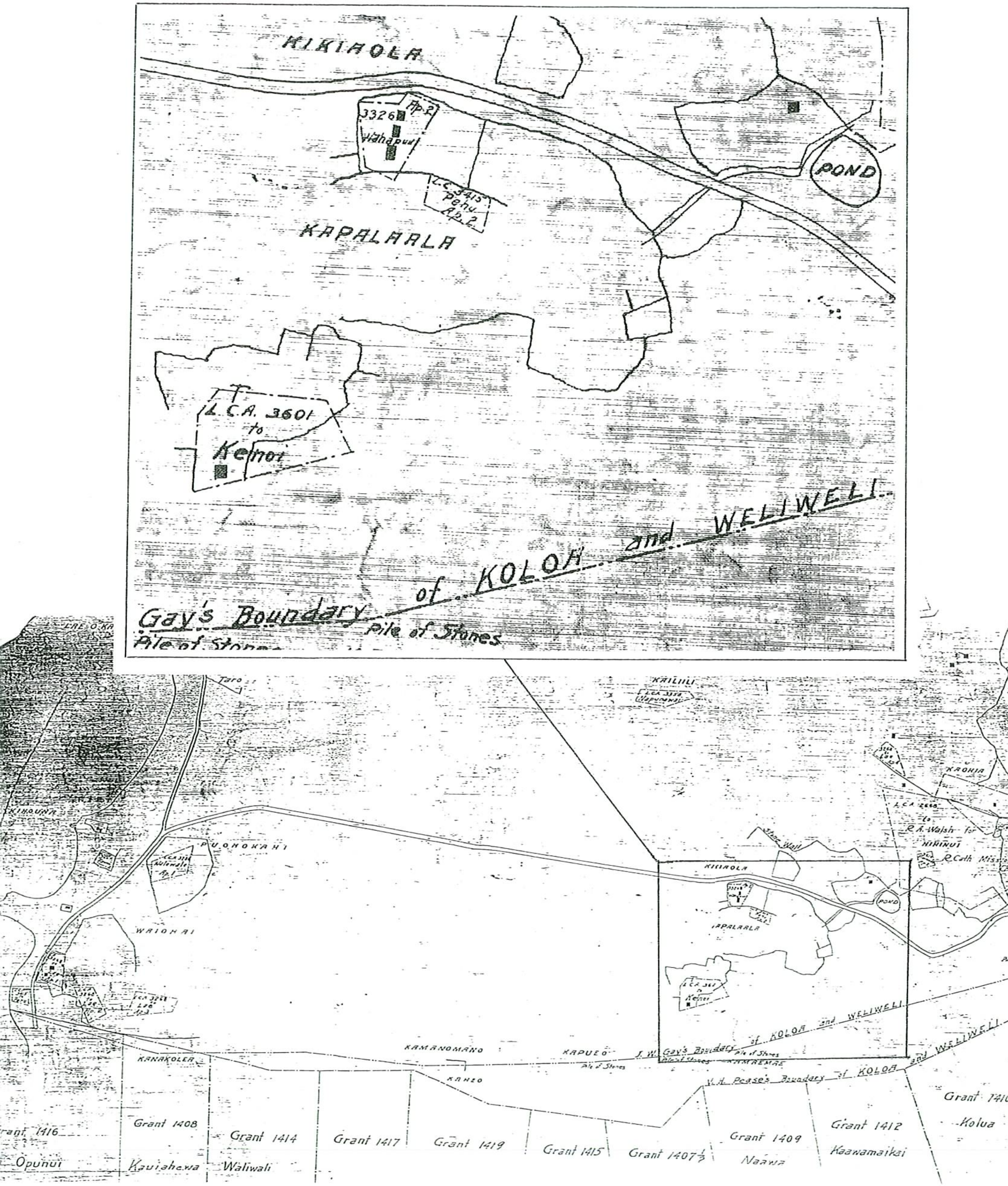

Fig. 5 M.D. Monsarrat Map of Project Area, circa 1891, Showing LCAs

Fig. 6 Kōloa Sugar Company Field Map, 1918 (from Conde and Best, 1973:160)

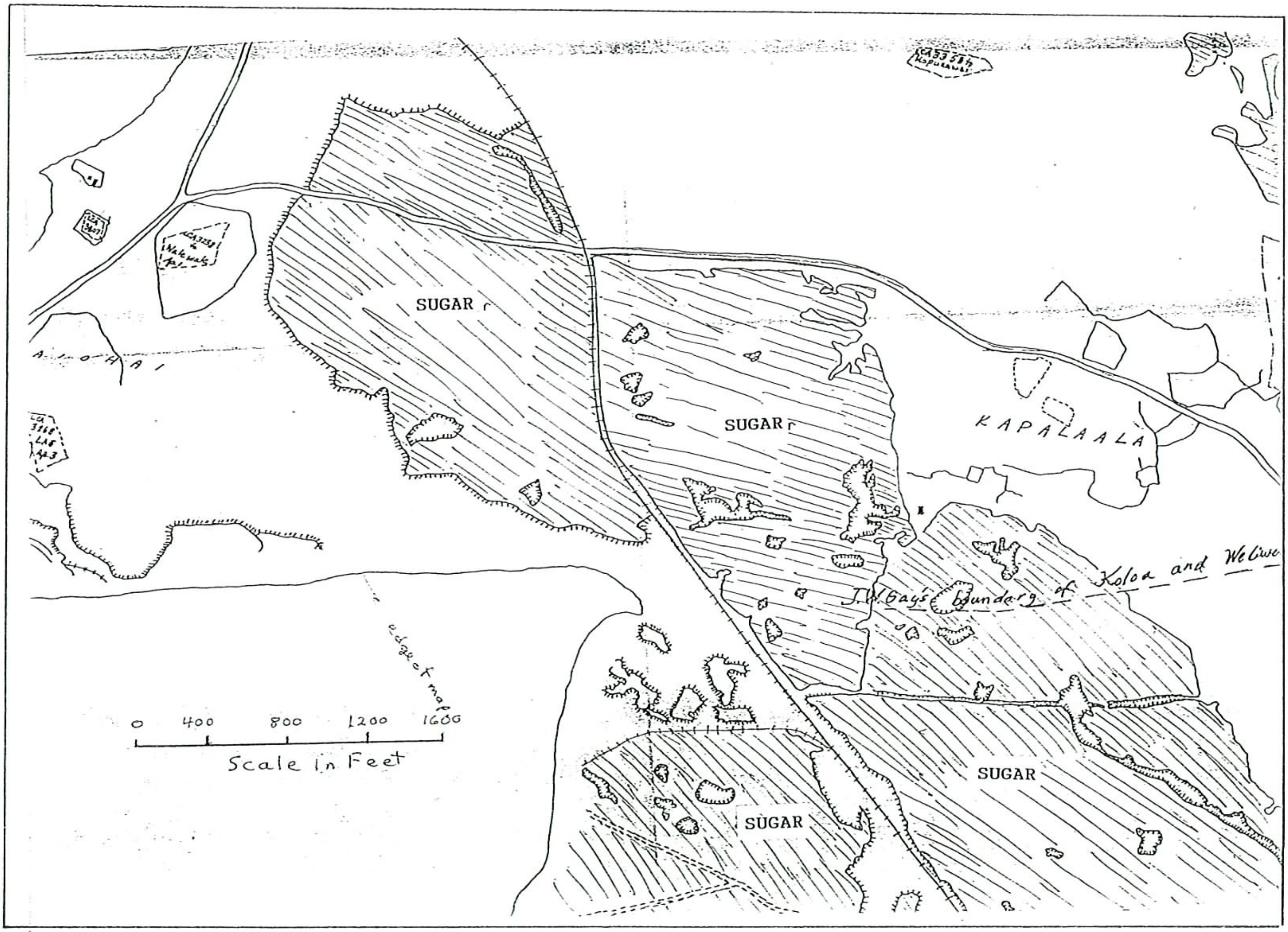

Fig. 6A Map of Lands Belonging to Koloa Sugar Co., C.R. Hunt 1911 (from Grove Farm) name. Moses Kekuaiwa was the brother of Alexander Liholiho (Kamehameha IV), Lot Kapuaiwa (Kamehameha V), and Victoria Kamamalu. The next largest award went to the Protestant Mission (ABCFM) and consisted of some 825 acres (LCA 387). The majority of the mission lands was located in the vicinity of Kōloa Town, where the parsonage is located, and were utilized for sugar cane cultivation and cattle pasture.

There were 3 LCA(s) awarded to individuals within the project area (Fig. 5). These LCA(s) are kuleana-type land holdings for house lots, kula and lo'i. The information from the Native and Foreign Registers and Testimony(s) indicate that during the mid-1850s traditional crops of taro and sweet potato were still being grown. The concentration of awards, including lo'i and house lots, was along 'auwai tapped from Waikomo Stream. The Registers and Testimonies offer a wealth of information. Most indicate the name of the applicant, number of lo'i, and size of kula, who they got the land from, or who entitled them to it, boundaries and neighbors, and numerous place names for the 'ili in the area. The general picture that emerges from this information is taro, grown in lo'i, was still the dominant crop within kuleana.

The 3 Land Court Awards from the project area with testimonies are listed as follows and are located on the 1891 Monsarrat Map (Fig. 5):

LCA BK		R.P.	BK
3326 8:235	Wahapuu	4187	17:371

Nat. Regis.
V9:35

Have 4 lo'i / in another place I have a cultivated place and a kula in sugar cane and a claim at Pohakuomakalii

For.Test.
V13:20

Kaanaana says land in "Kōloa Hikina." Received from Koakanu in 1825.
#1 Lo'i ai & 3 dry lo'i(s) in 'ili of Kaluaalamiki bounded mauka by Paehewa; Land
Puna by Namalu's lo'i
Makai by Josepha's lo'i
Hanapepe by "Kaiai Kamalie's" Land

#2 A cane field in the 'ili of "Kailiili" bounded mauka by 'ili of Manenehaahaa.
Puna by Kikiaola
Makai by land of Napunawai
Hanapepe by 'ili of Hikinini

#3 House lot and one lo'i in "Kikiaola" bounded mauka by my land
Puna by 'ili of "Kapalaalaea"
Makai by 'ili of PohankomaKalii"
Hanapepe 'ili of "Puahiepu

#4 3 lo'i in the 'ili of "Pohakuomakali"

#5 1 lo'i in the 'ili of "Kaliiaalamiki" called Panalako.

LCA BK		R.P.	BK
3415 4:758	Pehu in Waiohai, Kōloa	None	

Nat. Regis.
V9:35

3 taro lo'i, 3 dry lo'i, and a kula close to the lo'i(s)

For.Test.
V13:15

Kaanaana says Pehu's land in "Kōloa Hikina."
3 lo'i(s) and a kula in one piece in the 'ili of "Kapalaalaea," also a house lot in the 'ili of "Waiohai"

#1 bounded mauka by "Kikiaola", my land
Puna by an auwai & "Kamaemae," a kula
Makai by kula of Kapalaalaea
Hanapepe by Kikiaola, my land

#2 bounded by
    mauka the _kula_ of Waiohai
    Puna the _kula_ by Waiohai
    Makai by the sea beach
    Hanapepe by Waliwali's lot fenced with stone wall

Received #1 from Eke Apanui has had about 5 yrs and his house lot from the time of Kamuualii.

LCA	BK		R.P.	B
3601	4:770	Kenoi	3687	16:133

Nat. Regis. V9:69 — _'Ili_ of Kamaemae - right of occupancy from Koia/kanu until time of P. Kanoa. 3 _lo'i_(s) at Kamaemae bounded by Kikiola on the north, weliweli on the east, Kioea on south, Kapalaalaea on west.

For.Test. V13:17 — of Kaanaana land of Kenoi is in "Kōloa Hikina."

#1 _'ili_ of Kamaemae/from Koakanu in 1825

#2 3 _lo'i_ of Kahoana - bounded by _'ili_ of Kikiaola, Kiooa _'ili_, Kapalaalaea _'ili_ / from Eke Apunui in 1845.

LCA Information from native and Foreign Testimonies and Registers, Hawaii State Archives.

Correlation of Land Court Awards with archaeological sites is tentatively possible by matching locations of sites to award parcels as located on the 1891 Monsarrat map (Fig. 5).

LCA 3326 and 3415, located at the western boundary of the project area, in all probability correspond to Site 942. The large enclosing wall is probably the boundary of LCA 3326 and the habitation enclosure is probably one of the houses shown on the 1891 map. The exact definition of LCA 3415 on the ground is more difficult as the area has been bulldozed.

LCA 3601 to Kenoi is probably correlated to the agricultural complex of walls, fields and _'auwai_ of State Site 926 in the east central portion of the project area. There is no distinct house site which can be identified in this area but it has been heavily modified by ranching activity.

Summary

The historical information indicates that even though Kōloa is a relatively dry area (ca. 30 in. of rain per year), a perennially flowing Waikomo Stream allowed for a fairly extensive agricultural development. The present survey area had evidence of an expansive traditional agricultural complex and associated habitational features. Early historical accounts (Jarves, 1830; Townsend, 1839; Farley, 1907; Judd, 1835) describe a relatively continuous, well-maintained agricultural complex of taro, yams, sweet potato, and sugar cane that was watered by an extensive 'auwai system.

The Kōloa area became the site of Hawaii's first sugar plantation, Ladd and Co., in the mid-1830s. This brought about a general commercialization of the area, a move to a market-based society. Kōloa Landing became a busy port, not only for export of sugar and molasses, but other agricultural goods as well. Whalers stopped at Kōloa for salt, beef, pigs and squashes. The California Gold Rush was another impetus for agricultural exports with over 10,000 barrels of sweet potatoes shipped out of Kōloa.

During the mid-1800s the project area still had traditional farmers as evidenced by the kuleana(s) awarded and the information in the Native and Foreign Testimony(s) and Register(s).

However, this information also includes reference to commercial sugar cane growing. This suggests that though traditional farming was still taking place (i.e. for subsistence) market-oriented agriculture was beginning to dominate. Kuleana farmers were probably selling "excess" taro to native plantation workers, with kula lands producing cane to be sold to the mill, and sweet potatoes, yams and squashes grown to be sold for export.

It is not until the late 1890s that the makai area of Kōloa came under the full weight of commercial sugar cane cultivation. Kōloa Sugar Co., probably using some of the existing 'auwai system, planted the areas north and east of the project area in cane. E.S.C. Handy noted the preexisting taro terraces at Kōloa and briefly describes the area: "The terrace areas of Kōloa were as follows: Maenui, and Kahukini, watered from Wailana Stream; Niihau (upper Waikomo) near the Catholic Church (Kīahuna Golf Course area) and Keaku watered from Maulele (Maulili) Stream. Now these areas are not used for taro, because the water is taken by the sugar plantation" (Handy, 1940:65).

Kōloa Landing was phased out around 1925 with McBryde Sugar Co. and Kōloa Sugar Co. using Port Allen. Soon after this the companies ceased to use the makai Kōloa fields and much of the area was converted into pasture land. The present owners, the Knudsen family, runs cattle on this land.

Kōloa Settlement Patterns

Based on the information provided above, including the Monsarrat Map (Fig. 5), the following settlement patterns are reconstructed for 3 specific periods.

Late Pre-history

Extending early explorer eye witness accounts backwards in time and also using the by-now extensive archaeological survey information for Kōloa the following patterns emerge:

Extending westward from the Weliweli boundary to Kukuiula Bay was a continuous pre-historic irrigated agricultural complex which included spatially integrated lo'i in level areas, dryland terraces on higher bedrock bluffs, mound fields and small terrace fields in rocky areas with large platforms and enclosures of permanent habitation usually clustered in high areas or near 'auwai(s) and temporary shelters dispersed throughout the fields. The agricultural and habitation elements were spatially organized around a series of dendritic 'auwai which were the arteries delivering the water to keep the system alive. These 'auwai were tapped from Waikomo Stream on both the east and west banks near or directly below present Kōloa Town. The starting points of these 'auwai are not traceable today but through field survey they have been found nearly as far mauka as the present McBryde Cane Haul Road. The western extremity of this network was probably fed by 'auwai tapped from other smaller drainages above Kukuiula Bay.

The trademark of this pre-historic complex was the intensity of settlement and land use. In the most highly developed and best preserved segments - Kīahuna - there is barely a square foot which was not modified for lo'i, kula or habitation. The pattern of human settlement was simply a fairly even dispersal throughout the agricultural fields with the permanent habitation (kauhale) evenly spaced on high points or at 'auwai junctions. Water control was clearly a major factor in house placement. Temporary habitations (shelters, etc.) were clustered on field edges and the kauhale. In late pre-historic times the level irrigated lands of Kōloa from the Weliweli boundary to Kōloa Town to Kukuiula Bay and in most areas all the way to the shoreline formed a huge triangle of dispersed but continuous settlement with little or no spatial separation of house lots from agricultural land. The spatial separation of house lots along the shoreline and ag lands in mauka areas is less evident than along the Kona Coast of the Big Island and there is no barren zone or transition zone from makai settlement to mauka agricultural sites. The 'auwai recorded in Kōloa (Kīahuna, Kukuiula) are cut by the present beach roads and, in all cases where surveyed, extend to the shoreline where they have been destroyed by modern resort development. Fresh water was available for habitation and agriculture along their length. This means water was not a limiting factor which determined settlement zones and there was no localized dependency on rainfall variation. Even in time of severe drought the _'auwai_ fed by the _mauka_ ag waters would continue to flow.

Mid-to Late-19th Century

One of the best sources of information on mid-19th Century settlement patterns, besides voluminous documentary sources, is the 1891 Monsarrat map of Kōloa which shows Land Court Awards (LCA), major roads, some _'auwai_, and some taro and cane lands. The pre-historic pattern of continuous settlement of all lands from the present site of Kōloa Town to the shoreline is not evident. The major concentration of house lots and ag land awards is found around Kōloa Town with the A. P. Mission located here as the central focus of this settlement pattern. House lot and _lo'i_ land awards extend _makai_ from Kōloa nearly continuously along both sides of Waikomo Stream to Kōloa Landing which was by this time a major exporting point for local agricultural produce. Smaller secondary concentrations of _kuleana_ and houses not associated with LCAs occur at Kukuiula Bay (9 house structures and 1 LCA) around the A. P. Mission land behind present Prince Kuhio Park (5 house structures and 4 LCAs) and, thirdly, extending southeastward from Kōloa Town to the Roman Catholic Mission. This mission although established later than the A. P. Mission in Kōloa was a secondary center of settlement. It was founded in 1841 by Father Walsh and the present stone church was built in the 1850s (Judd, 1935:77). Two Land Court Awards _makai_ of the church are within the present study area.

The land west of Kōloa Town is shown in cane as was the land mauka of Kukuiula Bay.

What of the lands from the shoreline to the town of Kōloa which were all irrigated by 'auwai and show archaeologically dense agricultural and habitation use? Monsarrat's map shows blank space. All of these lands went to Kekuaiwa and included the majority of the lo'i lands. We know this land was in full production in the mid-19th Century as evidenced by the large exports of food supplies in the 1850s and 1860s (Judd, 1935). Kekuaiwa was the chief who probably controlled the bulk of the crop production in this peak period and his tenants lived and worked these lands to supply him with supplies to export but were not claimants to it.

Commercial Sugar Period

The earliest commercial sugar cane was grown by native farmers in small plots as evidenced by the LCA testimonies which mention sugar fields next to taro lo'i. The rocky terraced lands were avoided for large scale production partly because they were valuable for food crops and partly because of the labor involved in laying out large fields. The larger irrigated fields were, however, put into cane when it was profitable to replace taro, and, after the California export boom, for food crops. Most of the Kīahuna project area and some of Kukuiula area were simply abandoned in place and became Knudsen grazing land. The larger, irrigated fields were leveled and expanded for commercial sugar from the 1880s onward. The ancient 'auwai continued to supply water. Meantime the deep soiled mauka land west and east of Kōloa Town, where rainfall was sufficient, were already mantled with sugarcane.

The extent to which sugar fields encroached into the ancient terraced lo'i land of the Po'ipulani Project area is shown on a 1911 map of lands belonging to Kōloa Sugar Co. (Fig. 6A). The sugar was planted on both sides of the railroad berm with only small rocky islands excluded. Sugar is not shown mauka of the 3 Land Court Awards but there is evidence from the archaeological survey - i.e., open areas, lack of sites, rock clearance, and large level areas with low barely detectable earthen mounds - that sugar was grown here as well, quite possibly after 1911.

Age of Sites and Depth of Subsurface Cultural Deposits

There is some comparative information on which to base an estimate of time range for the Po'ipulani sites. Excavations were conducted in the Kīahuna area west of the Po'ipulani project area and east of Waikomo Stream. Some dating results are available for this project. The age range for the Po'ipulani sites can be based on what we know of broad prehistoric/early historic patterns on Kaua'i and in Hawai'i in general. To date, the earliest C14 dated occupation on the south coast of Kaua'i is from cultural layers at Keoneloa Bay in Paia with age ranges from as early as A.D. 220 - 690 representing intermittent short-term beach occupation (Rosendahl & Walker, 1990:313). Intensive development of irrigated _lo'i_ came after A.D. 1100-1200 and the non-flood plain, pahoehoe terrain of Kōloa would have been one of the later systems in the sequence. The earliest irrigated agriculture here probably post-dates A.D. 1400 and the system was probably not intensified until the late prehistoric period and continued in use to supply whaling ships in the Post-European Contact Period. The caves probably contain older cultural deposits, but most of the prehistoric surface features will post-date 1400 and will probably cluster around the A.D. 1700-1770 range.

A series of 18 C14 dates from Kīahuna reinforces this interpretation. The cave sites show nearly continuous occupation from A.D. 1000 onwards. And the surface sites associated with agricultural development post-date A.D. 1400-1500. There is, however, one early date for a habitation platform-A.D. 890±170-but this is considered too early for the development of intensive irrigated agriculture. So far at Kīahuna there is one dated _'auwai_ with an age range of A.D. 1325-1430. This age appears to mark an early construction phase of the _'auwai_ and is considered a reasonable age for the onset of irrigated planting.

We expect the Po'ipulani portion of this agricultural complex to be slightly later, given its greater distance from Waikomo Stream - the course of water for virtually all of this ancient enterprise.

As for the depth of deposits under sites (except for caves), based on the similar sites in the Kīahuna and Kukuiula, maximum depth to bedrock will probably be in the range of 30-60 cm. Cultural deposits within caves are expected to be one meter or deeper depending on the amount of historic illuviation.

III. PREVIOUS ARCHAEOLOGICAL RESEARCH

There have been a number of archaeological studies in the Kōloa area, but most of this work has been limited to short-term reconnaissance surveys. The earliest is a listing of temples and shrines (Lahainaluna Schools, 1885), some of which are near the present study area. The most important is Maulili Heiau.

> The first heiau of southern Koloa. Kapulauki was the first chief of Koloa, Kiha came next. This Kiha was called Kiha of the luxuriant hair (Kiha-ke-oho-lupalupa). Another name for him was Kaka'e and another was Ka-pueo-maka-walu. Men were sacrificed on it. The heiau was famous because Kawelo was laid on its altar. Kiha lived on the eastern side of the heiau, and Aika-naka on the northeastern side.

There are three areas in Kōloa named Maulili. One is along the coast and is called Maulili-kai. One is inland near the project area. The third is in the town of Kōloa (Kikuchi, 1963:84).

Other religious structures are described:

> Kue-manu Heiau: It was located in Kualu in Koloa. Kualu was the chiefess who built it, but any story pertaining to this heiau is not remembered. Human sacrifices were offered there. There was a heiau at Wailua similar to this one so it was thought the same chiefess built that one too.
>
> Manini Heiau: Manini was another heiau of Koloa. It stood near the beach. The heiau was for the gods of the sea, that is Kuhaimoana and others. On the nights of Kane these fish-gods came up to the beach. Their spirits took possession of their keepers, then these men went into the heiau to drink awa. The people were accustomed to doing this in the olden days. On each night of Kane in every month, the drum was beaten to proclaim a kapu on the beach. Men were not allowed to go to the beach at night lest they step on the fish (gods).
>
> Kuhahapo Heiau: Kuhahapo was another heiau. It was located on the Cape of Kahala in southern Koloa. Hogs and red fish were offered there. The chief who built it is not known.

Louma Heiau: Louma was another heiau, which also stood in southern Koloa on the mountain side of Ho'o-leina-ka-pua'a (place-to-throw-in-the-pig), a pond on the mountainward side of the houses. The heiau was close by. Kiha was the chief to whom it belonged. It was a small heiau in which hogs, red fish, etc. were offered. Lonoikaoualii was the chief and Wakea was the priest who brought the stones from Oahu.

Hale-oio Heiau: Haleoio was another heiau. It was also in southern Koloa, on the beach. The thing for which this heiau is noted was that when schools of Weweo (a red fish) went to Kahaoi, they also came to this place.

Kaulia Heiau: Kaulia was another heiau. It was very close to the eastern side of Kamohoalii's taro patch, because the heiau was also his. It was a heiau in which to offer hogs and red fish, for the relief of physical ailments. That was the only thing done in this heiau.

Mauna-pohaku Heiau: Maunapohaku was another heiau. It stood on Nahinu's property in southern Koloa. The name of the chief who built it and that of the priests who officiated there is not remembered.

Ka-i'a-iki Heiau: Kaiaiki was another heiau that stood on the mountainward side of the road leading down to the wharf at the landing. It was on the eastern side in southern Koloa.

Kuhahape Heiau: Kuhahape was another heiau which was located by a seapool on the beach of Koloa.

Halau-a-ka-lena Heiau (Site 50-30-10-3074): The heiau now completely destroyed once stood at the shore at a promontory called Kai-halulu. Kihawahine was its goddess. Dogs, hogs, and red fish were offered there in the olden days. In times of trouble such as sickness, the priests took offerings there.

Kamalo'ula Heiau (Site 50-30-10-3076): Located at Kamaloula, that was the site of Makea's house (female). This heiau was built for the purpose of multiplying food plants.

Ho'ai Heiau (Site 50-30-10-75): Located at the birth place of Prince Kuhio. The heiau complex consists of 5 separate platforms all interrelated to each other. Most were paved .... A round fireplace with sand bottom was noted on one of the platforms. A rectangular pit had two unusual stones shaped like the human foot or lower leg. Evidently these were items of worship.

Kiha-Houna Heiau (Site 50-30-10-80): Kiha-Houna. Heiau for the gods who are Hulukoki, Kane, Kamohoali'i and Kuhaimoana. The heiau was dedicated to these gods.

Kane-i-olo-uma Heiau (Site 50-30-10-81): ... on the shore a short distance east of site 80 ... at Po'ipu, Koloa ....

Papa Shrine: Papa was a fish altar on the beach on southern Koloa. It was a place on which red fish and hogs were offered and was also a place on which the fishermen's first catch was laid (Kikuchi, 1963).

Bennett carried out a survey in 1929 in which he designated a number of sites (50-30-10-76, 77, 78, 79, 80, 85, and 86) in the general vicinity of the study area (there are numerous other recorded and unrecorded sites known in the ahupua'a of Kōloa). Of the ones mentioned above only 50-30-10-86 and a portion of Site 85 are within the project area.

Site 50-30-10-85 consists of walls, enclosures, and house sites:"... in the cactus covered country around the Koloa reservoir and extending to the sea.

Innumerable walls, some of them inclosures and some merely division walls and fences. In one large, walled inclosure were three piles of stone near one end. The center one, and the largest, was 10 by 7 feet and 2 feet high. It was built up around the edge with large stones and filled with 2-inch pebbles. On each side of this structure was a 3 by 3 by 2-foot pile of rocks. There are some fine house sites on flat places on the lava flows, slightly leveled with small stones. House sites about 10 by 15 feet are found everywhere on the lava. The walls are of different types of construction and some have been restored for modern use; double rows of large stones on edge filled in small stones; walls built up of same size stones; walls built of blocks of lava set upright. Some walls are 6 feet and others 2 feet high. (Bennett,1931:120)

Site 50-30-10-86 is described as a house site. Although Bennett does not locate this site, it is probably Site 944 located in the present study area.

> This special house site is rectangular, 25 feet wide, and 45.5 feet long, inclosed by walls 2 feet wide and about 2 feet high. It is divided into two sections. The south section is paved with small stone and has a terrace across the southern end. East of this section, outside the wall, is a roughly paved irregular area. The roughly paved north section is one foot lower than the south section, the walls being correspondingly higher. Outside the west wall of this house near the center is a paved platform in which is a square depression. The walls of this house site are made of double rows of stones on edge with a small stone fill between them. Coral is found in the walls. Southwest of this site is another, with walls on three sides only, which measures 15 by 15 feet (Bennett, 1931:120).

Outside the project are other sites mentioned below. Site 76 consists of numerous salt pans, east of Waikomo Stream along the shore. Site 77 consists of four ponds just inland from the shore road east of Site 76. Site 78 is a series of taro terraces and habitation areas, just east of Site 77 and adjoining it. Site 79 is a large enclosure and house sites just northeast of Site 78.

Site 50-30-10-80 Kiha-Houna Heiau, located on the point between the Waiohai and Po'ipu Beach Hotels, is significant as the only surviving major religious structure located along the south coast of the Island of Kaua'i. It has been restored on the grounds of the Waiohai Hotel. It is one of the only two heiau still located along the entire District of Kona (the other being Polihale Heiau, Site 50-30-01-1) although others may be extant — but not recorded.

The earliest detailed archaeological site surveys were carried out by Kikuchi in 1961 and 1963 from Hanapepe to Māhā'ulepū. Although no sites were recorded as being definitely in the present project area, several sites were listed but not located and could possibly be near this study area.

During the 1973-1974 State-wide Inventory of Historic Places performed by A.R.C.H. of the County of Kaua'i for the State of Hawai'i, archaeological remains in the present project area (Site 50-30-10-85 and 86) were briefly evaluated and placed on the Reserve status. The exact location and extent of these sites were not clearly defined at that time. Archaeological sites were placed in Reserve status because they needed additional research and should be saved until they could be placed into one of the other categories. These included: 1) High Value - sites that must be saved; 2) Valuable - sites that should be saved; 3) Marginal - can be destroyed with reservations; 4) Destroyed - all traced obliterated. These categories are no longer in use in State-sponsored surveys.

At least ten archaeological reports were generated from work in the Po'ipu-Kōloa area in the 1970s and early 1980s (A.R.C.H. '80; Bordner '77a; Bordner'77b; Ching '74a; Ching '74b; Hammatt '78; Kikuchi '80; Landrum '84; Neller '81; Sinoto '75). Most of these documents are short "letter" reports detailing the results of walk-through reconnaissance surveys. By far the most ambitious of these projects was the "Archaeological and Biological Survey of the Proposed Kīahuna Golf Village Area" (Hammatt, 1978) which recorded 583 archaeological features in a survey of 460 acres including the _makai_ portion of the present study area west to Po'ipu Road.

The results of the Kīahuna survey show intensive prehistoric modification of the rocky landscape into an almost continuous complex of irrigated agricultural fields interconnected with _'auwai_ (ditches) and thickly scattered with habitation sites on higher ground around the fields. This complex, all irrigated by water tapped from Waikomo Stream, extended eastward and westward an unknown distance. Since sugar cane cultivation and housing developments have altered much of the area, the irrigated fields and stone-lined ditches can only be traced eastward to the west boundary of the present study area. Clearly, the remnant of this former Hawaiian agricultural community is one of the outstanding examples of ancient land use in Hawai'i.

In 1982 Robert Connolly prepared an archaeological reconnaissance report for land which included the eastern portion of the present study area. He provides rough locations and brief descriptions of most of the sites on a proposed corridor of the Kōloa-Po'ipu Bypass Road.

In 1981 Dr. William Kikuchi conducted an archaeological Reconnaissance of a 66-acre parcel in Weliweli (TMK 2-8-22:6) which borders the present project area to the east (Kikuchi, 1981). Kikuchi recorded a number of _'auwai_, terraces, walls and habitation sites in this tract which had been extensively bulldozed. There were enough site remnants present to conclude that the area was once part of the vast prehistoric agricultural network which covered much of the rocky land in Kōloa and Weliweli.

In 1985, Cultural Surveys Hawaii performed an archaeological Survey and Testing project in the proposed Kōloa-Po'ipu Bypass Road (Hammatt et al., 1985). This investigation covered the south and eastern portion of the present Po'ipulani project area and included remapping of A.R.C.H. 1978 Kīahuna sites northward to the Railroad berm as well as location of a number of new sites along the Kōloa-Weliweli boundary. Subsurface testing included 15 test pits within 10 separate small occupation sites. None of these sites showed significant cultural remains and the testing results indicate short-term occupation, probably in conjunction with field labor. Two of the sites tested are within the present project area (Site 900, Site 968).

The most recent archaeological study of the project area is an investigation by Joseph Kennedy (1990) (Archaeological Consultants of Hawaii). In this letter report Kennedy mentions a cave site in the northern portion of the study area (Site 946) and other sites in the south and west portion. There is no map showing site locations but he recommends a complete survey of the parcel.

V. SURVEY RESULTS

All of the archaeological sites located in the project area are shown on the map (Fig. 4) and are described below. Sites previously located in the 1978 Survey (Hammatt et al., 1978) are assigned their original site numbers (400 & 800 series). Sites located in the 1985 survey of the proposed Kōloa-Po'ipu Bypass road alignment (Hammatt et al., 1985) are given numbers CSH 1-9. Sites located in the present survey were assigned numbers CSH 101-137. All of these numbers are considered field numbers and each of these is given a corresponding state site number. These state site numbers begin with 50-30-10-xxx, but will be discussed in this report by their last 3 digits. Each of the sites is described by order of State numbers. A summary site list is shown in Table 1 and Table 2 in Section V. No artifacts or midden were observed in any of the sites unless otherwise indicated in the descriptions. Ages of sites and functional categories of sites are listed in Table 2. Sketch maps were prepared for all sites except rocky agricultural sites which consist only of amorphous rock pilings with no definite form (Sites 944, 970); only selective examples of site maps are included in this report. Individual maps of typical C-shapes and typical 'auwai are not included here as they would be repetitious.

State Site 900

Description (Figs 7 & 8):

This site is a roughly rectangular, permanent habitation platform of pre-historic age measuring 20' x 40' (6.1 x 12.2 m.).

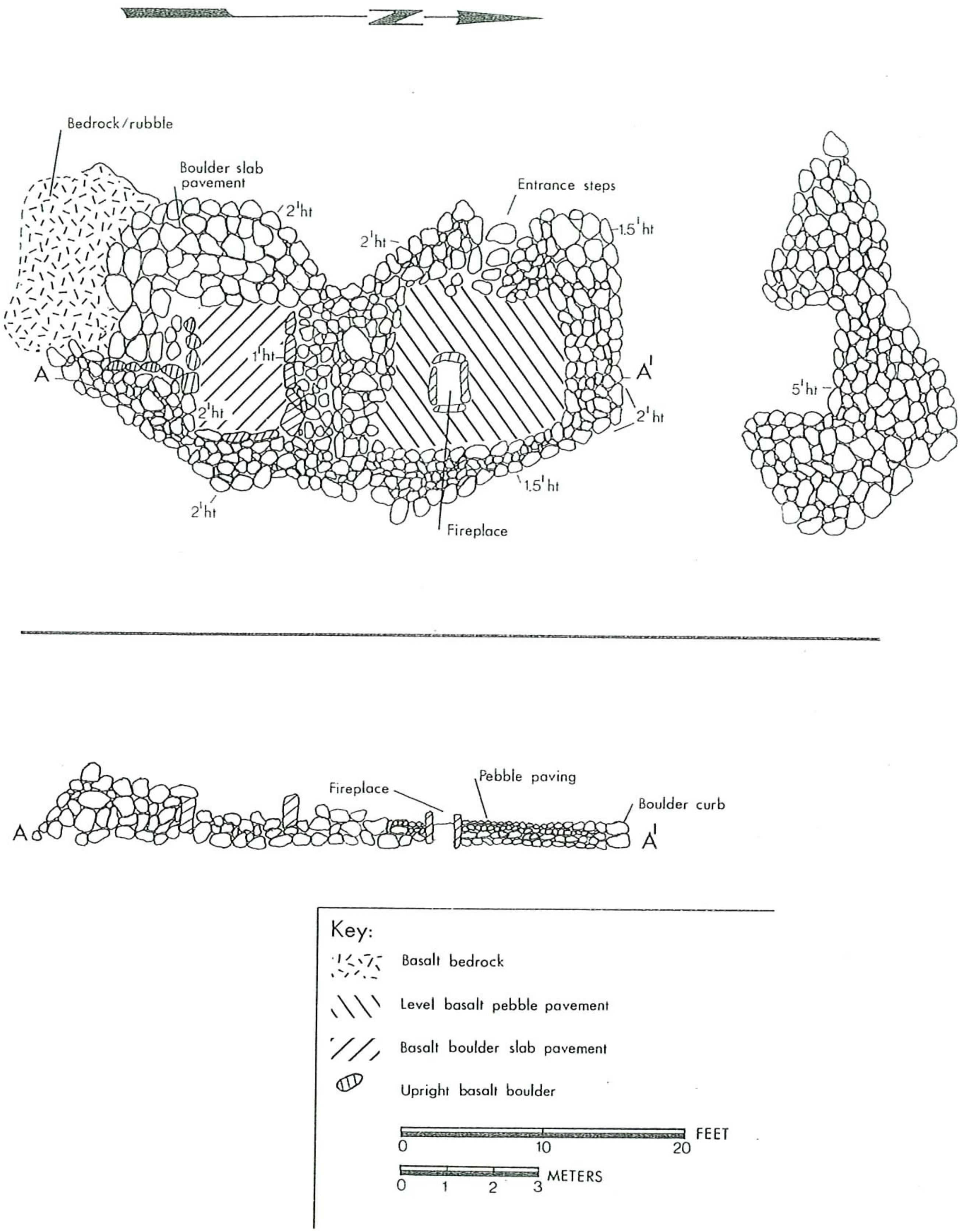

Fig. 7 State Site 900, Plan View and Cross Section

Fig. 8 State Site 900, Northern Portion of Platform Showing Stone Lined Hearth, View to West

The platform is a maximum of 2.5' (.8 m.) high and is very well constructed. There are two paved areas on this platform. The southern area is paved with boulder slabs. The northern area is pebble paved and contains a rectangular stone-lined hearth. There are two associated features: one a C-shaped structure adjacent to the north, the other a rectangular enclosure to the southwest. The C-shape measures 15' (4.6 m.) x 25' (7.6 m.), with an interior area of 6' (1.8 m.) x 8' (2.4 m.) and maximum back wall height of 5' (1.5 m.). The enclosure measures 12' (3.7 m.) x 15' (4.6 m.) with an interior area of 6' (1.8 m.) x 7' (2.1 m.). The walls of the enclosure are well-faced and are a maximum 2.5' (.8 m.) high. This site, a possible "kauhale," is probably associated with the large agricultural system (832 complex) which is approximately 50-60' (15.2-18.3 m.) to the west.

State Site 901

Description:

State Site 901 is a pre-historic agricultural field system consisting of numerous small amorphous mounds and little soil pockets in an area of exposed pahoehoe bedrock. The mound field is surrounded by a wall 3' (.9 m.) wide which ranges in height from 1.5-2.5' (.5-.8 m.) and is constructed of loosely piled boulders. The wall encloses an area of 100' (30.5 m.) E/W by 100' (30.5 m.) N/S.

State Site 902

Description (Fig. 9.):

This site is a large C-shape (temporary habitation) measuring 18' x 20' (5.5 x 6.1 m.) with a maximum back wall height of 3.5' (1.1 m.) and an interior area of 6' x 10' (1.8 x 3 m.). The interior is mostly soil with some loose boulders, the result of wall collapse. One test unit was excavated in the interior of the C-shape. This is a pre-historic site.

Excavation Results (From Hammatt et al., 1985):

Test Unit 1, a one-square meter unit, was excavated in the southwest portion of the interior of the C-shape. It revealed a maximum of 30 cm. of soil overlying pahoehoe bedrock and sterile subsoil (C-horizon). There was very sparse shell midden (approximately 10 grams) and no artifacts. However, a small fire hearth was noted in the northeast quad of this unit and a charcoal sample was collected. The hearth was cobble and boulder lined with the largest of the rocks visible on the surface. The hearth was about 40 cm. in diameter and a maximum of 30 cm. thick.

State Site 903

Description:

State Site 903 is a collapsed C-shape measuring 12' x 18' (3.7 x 5.5 m.). The remaining intact wall has a maximum height

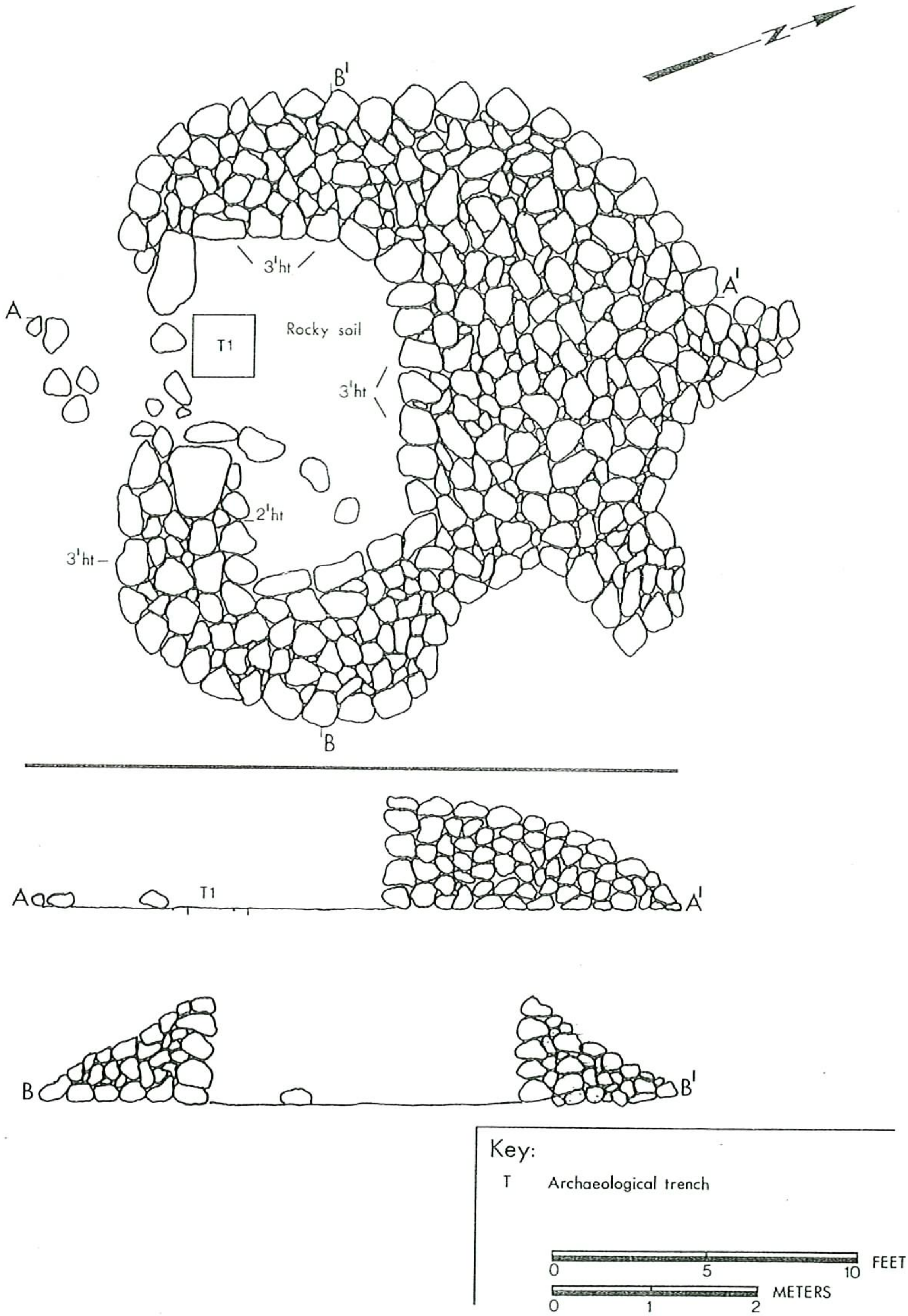

Fig. 9 State Site 902, Plan View and Cross Section

of 2.5' (.8 m.) and is 3' (.9 m.) thick. The interior surface is loose boulders on bedrock, with soil pockets in bedrock cracks. This is a pre-historic temporary habitation site.

State Site 904

Description:

State Site 904 is a small C-shaped shelter measuring around 6' (1.8 m.) in diameter. The interior area measures 3' x 4' (.9 x 1.2 m.) and has a bedrock surface. The back wall is constructed with stacked boulders and one incorporated upright slab to a maximum height of 1.5' (.5 m.). This is a pre-historic temporary habitation site.

State Site 905

Description:

This large C-shaped shelter measuring 20' x 25' (6.1 x 7.6 m.) with an interior area of 8' x 12' (2.4 x 3.7 m.). The walls are somewhat collapsed, but the intact portion has a maximum height of 3' (.9 m.) The interior surface is loose boulders on bedrock. This is a pre-historic temporary habitation site.

State Site 906

Description:

This square mound is 5' (1.5 m.) high on the makai or south-east corner, 6.5' (2 m.) square at the base, and 5' (1.5 m.) sq. at the top. It has a depression in the middle, possibly from rock or pot hunting. The site has well-faced sides, some uprights, some slabs lying flat, a few larger boulders, mostly small boulders, and cobble-sized rocks on the top. There are two 3' (1 m.)-high rough mounded agricultural walls 30' (9 meters) long oriented roughly N/S which appear to be forming a rough elongated field. Agricultural mounds and amorphous rock pilings on bedrock are located to the south of the site. This is a pre-historic agricultural site.

State Site 907

Description:

This is a very crude L-shaped structure built on bedrock. The wall to the NE side is built on top of a widespread bedrock bluff adjacent to Sites 964 and 965. The maximum dimensions are 6.5' (2 m.) E/W bearing 306° TN x 3' (.91 m.) N/S. Maximum height of the wall at the point of the L is 3' (1 m.); maximum width of the wall is 1.5' (.5 m.). No cultural midden or artifacts were observed. The bedrock bluff is modified superficially with rock pilings but no midden or artifacts were observed and no outstanding examples of construction style or technique are evident. Structures present are very rough and crudely built. This site has no excavation potential and no soil deposits. It is a pre-historic agricultural site.

State Site 908

Description:

This is a large, low-paved, temporary habitation platform with a probable hearth in the center. Numerous medium-sized slab boulders are laid flat on the platform surface with pebble and cobble fill. Dimensions are 23' (7 m.) E/W x 20' (6.1 m.) N/S. An 'auwai section (Site 969) approaches the platform from the N, circles around the east side of the platform and exits away from the platform to the south, branching into 2 possible channels or more. One channel may go towards the east. Platform elevation is no more than 50-60 cm. above the surrounding ground surface which is very rocky terrain, sloping steeply to the south. No cultural material (midden or artifacts) whatsoever were observed. This site is estimated to be pre-historic in age.

State Site 909

Description (Fig. 10):

State Site 909 is a 2-level, large boulder probable temporary habitation platform, built off a high outcrop which slopes towards the south. The platform is approximately 21.4' (6.5 m.) wide E/W, and is divided into 2 terrace levels. The N/S dimension of each terrace is approximately 13' (4 m.). Bulldozing on the mauka side has disturbed the mauka edge of the platform. There is a possible fireplace in the upper level of the platform, centrally located. It is surrounded on the S and E and W sides by very rocky, small agricultural fields and on the north side by very recent intensive bulldozing. The platform is constructed of many large boulders but pebbles and cobbles form the surface of the upper level along with a number of small boulders laid flat as paving. Two other nondescript pits are present, one at the joining of the upper and lower levels of the platform and one on the west side of the upper level of the platform. These are possible cupboards that have been opened in the past and left open. The upper platform surface is approximately level with the ground surface to the north and falls off to the south and the southern facing of the lower level platform is approximately 3' (1 m.) in height. The elevation difference between the upper and lower levels of the platform is approximately 50-70 cm. No cultural material (no midden or artifacts) was observed.

State Site 910

Description:

State Site 910 is a small C-shaped remnant for temporary habitation located in a rocky area. The wall is on the E side, against the prevailing wind. There is one upright in the interior of the E wall. The interior is filled with rock and rubble. The surrounding area is all rocky agricultural-type features and this may in fact be an agricultural feature. No midden or artifacts were observed. The maximum internal N/S dimension is 6.5' (2 m.) and internal E/W dimension is 5' (1.5 m.). The maximum internal height of the E wall is 70 cm. Maximum wall width is 5' (1.5 m.). It is a pre-historic site.

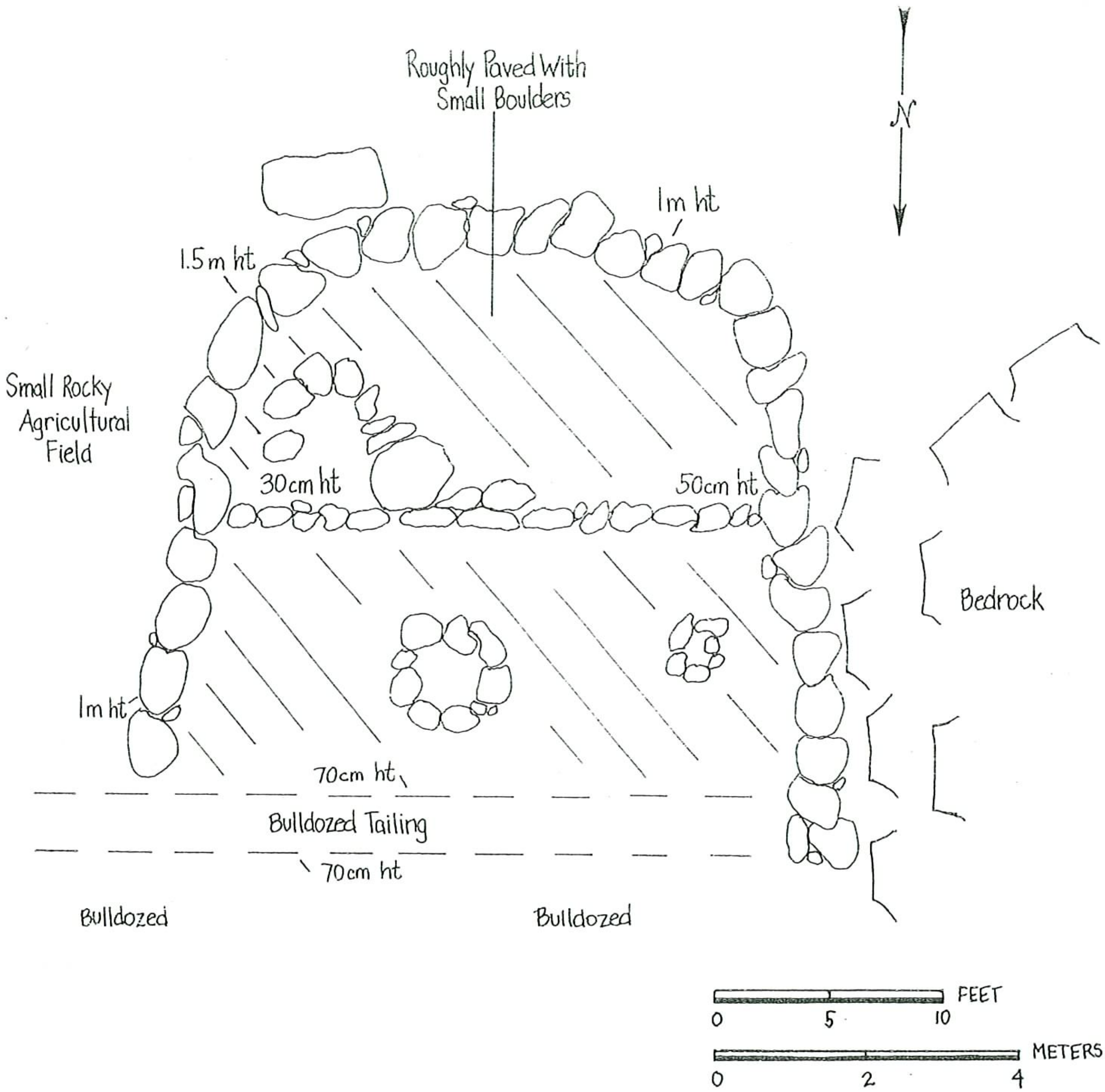

Fig. 10   State Site 909, Plan View

State Site 911

Description:

State Site 911 is a 6.5' (2 m.) long, roughly N/S-running wall that was the back wall of a C-shaped temporary habitation shelter or some other structure, the remainder of which has been bulldozed on the W side. The wall is 1.5' (.5 m.) high and a maximum of 6.5' (2 m.) wide. The site is in poor condition. No midden or artifacts were observed. The site is estimated to be pre-historic.

State Site 912

Description:

State Site 912 is a probable C-shaped temporary habitation shelter which would have been open to the west before it was damaged. The maximum exterior dimensions at the present are 13' (4 m.) N/S by 10' (3 m.) E/W. It is built off an easterly sloping bluff. The interior maximum dimensions would have been 5' (1.5 m.) N/S by unknown distance E/S. The site is presently an island in the middle of bulldozing and is heavily damaged. No midden or artifacts were observed. This is a pre-historic site.

State Site 913

Description (Fig. 11):

This is an agricultural complex consisting of 4-5 well preserved terraced fields surrounded by well-constructed thick field walls. The entire complex measures approximately 200' (61 m.) E/W x 180' (54.9 m.) N/S. This is a remnant of a wet irrigated agricultural system which is fed by a well-preserved _'auwai_. Site 913 _'auwai_, which enters from the NW, is easily visible as two parallel alignments coming downslope into the terraced fields. On the W side of the _'auwai_, as it enters the first field, is a large mound of piled rocks on top of which stands a habitation platform which is paved and level on the upper surface. The platform is sloping around the edges but the upper surface is paved with cobbles and pebbles. The S side of the platform is a well-preserved facing approximately 2' (.6 m.) high. The platform measures approximately 10' (3 m.) square on its upper surface and, including the sloped area, is approximately 15' (4.6 m.) square. The platform overlooks the _'auwai_ which is to the E of it and downslope. The lower facing of the platform on the E side is the W wall of the _'auwai_. This platform is referred to as Feature A of State Site 913. There is shell midden visible to the E of the platform and going downslope. On the W side of the platform are other paved areas on bedrock slopes which could also contain occupation material. Thirty feet (9.1 m.) to the SW of the platform is a cupboard feature built into large rocks as part of a thick field wall. The platform Feature A is the only habitation feature identified within this agricultural complex. The bedrock bluff on which it stands has been heavily modified and in itself forms a terrace which stands 5-6' (1.5-1.8 m.) in elevation above the surrounding fields

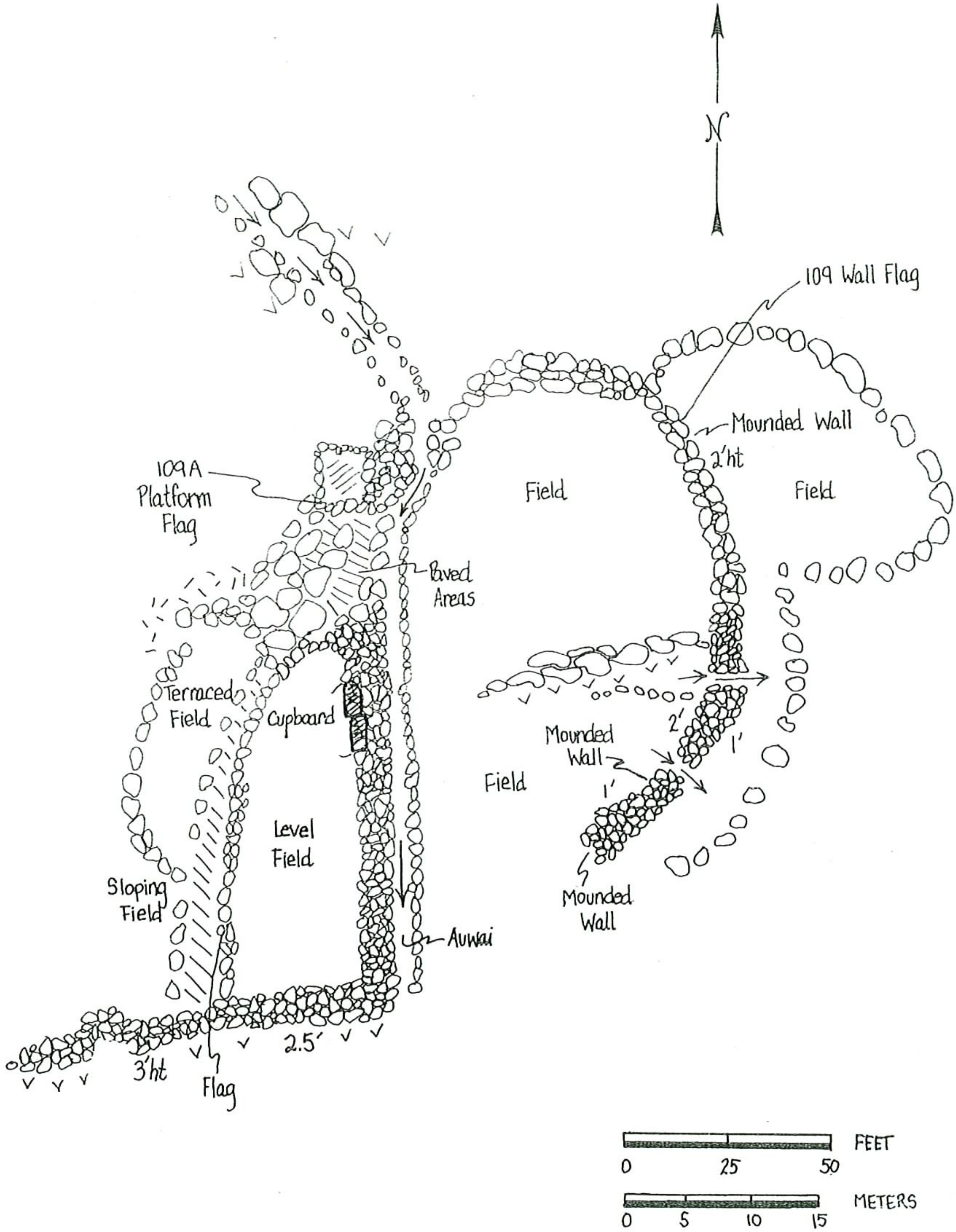

Fig. 11 State Site 913, Plan View

below. Some of the level terraced fields have rock mounds within them. There are water entries and exits still visible. As mentioned, the walls are massive, sometimes 8-10' (2.4-3 m.) thick, mostly core-filled, and are clearly well-developed terrace field walls. The _'auwai_ which enters this site complex is traceable _mauka_ for over 1000' (304 m.) and is one of the larger _'auwai_ in the project area. Considering the _'auwai_, the irrigated fields, terraces, and the habitation together, this site forms one of the best-preserved and most integrated pre-historic sites in the project area. To the west of the complex along this slope, extending to approximately 250' (75 m.), is a rocky agricultural area consisting of amorphous rock piling and low, linear mounds; one, a shaped terrace (open _makai_) lies at the base of the slope, approximately 70' _mauka_ of the railroad berm. This terrace, referred to as Feature B, is 40' (12 meters) long and 25' (75 meters) wide with walls 4' (1.2 m.) wide and 2' (60 cm.) high. This is the only discrete feature in the area and is an agricultural field of pre-historic age. No midden or artifacts were observed.

State Site 914

Description (Fig. 12):

This site consists of a mound probably the result of stone clearance for agriculture. The mound measures 33' (10.1 m.) N/S and 15' (4.6 m.) E/W and forms a roughly rectangular shape. A 1' (.3 m.) high, 3' (.9 m.) wide linear mounded wall extends off the center of the east side for 10' (3 m.). The top of the mound consists of small boulder and cobble paving. There are no clearly defined facings and the mound stands 1' (.3 m.) above the surrounding terrain. This is estimated to be a pre-historic site.

State Site 915

Description:

This L-shaped terrace or shelter site consists of two joining perpendicular walls. The longer N/S wall is 25' (7.6 m.) long. The shorter E/W wall is 17' (5.2 m.) long. Both walls are 7' (2.1 m.) wide and 2' (.6 m.) high. The interior facing of the walls incorporates a few uprights along the long axis. There is a possible small cupboard or posthole in the N/W portion of the short wall formed by a depression 8 inches (21 cm.) in diameter and 1' (.3 m.) deep. The sheltered area of the interior is rocky and may have been paved. A possible interior alignment is oriented NW to SE. This is a pre-historic temporary habitation shelter.

State Site 916

Description:

This is a modified outcrop, probable agricultural clearance mound, measuring 23' (7 m.) N/S by 18' (5.5 m.) E/W and roughly rectangular. There is some rough facing on the south and east sides. The north and west sides are level with a bedrock out-

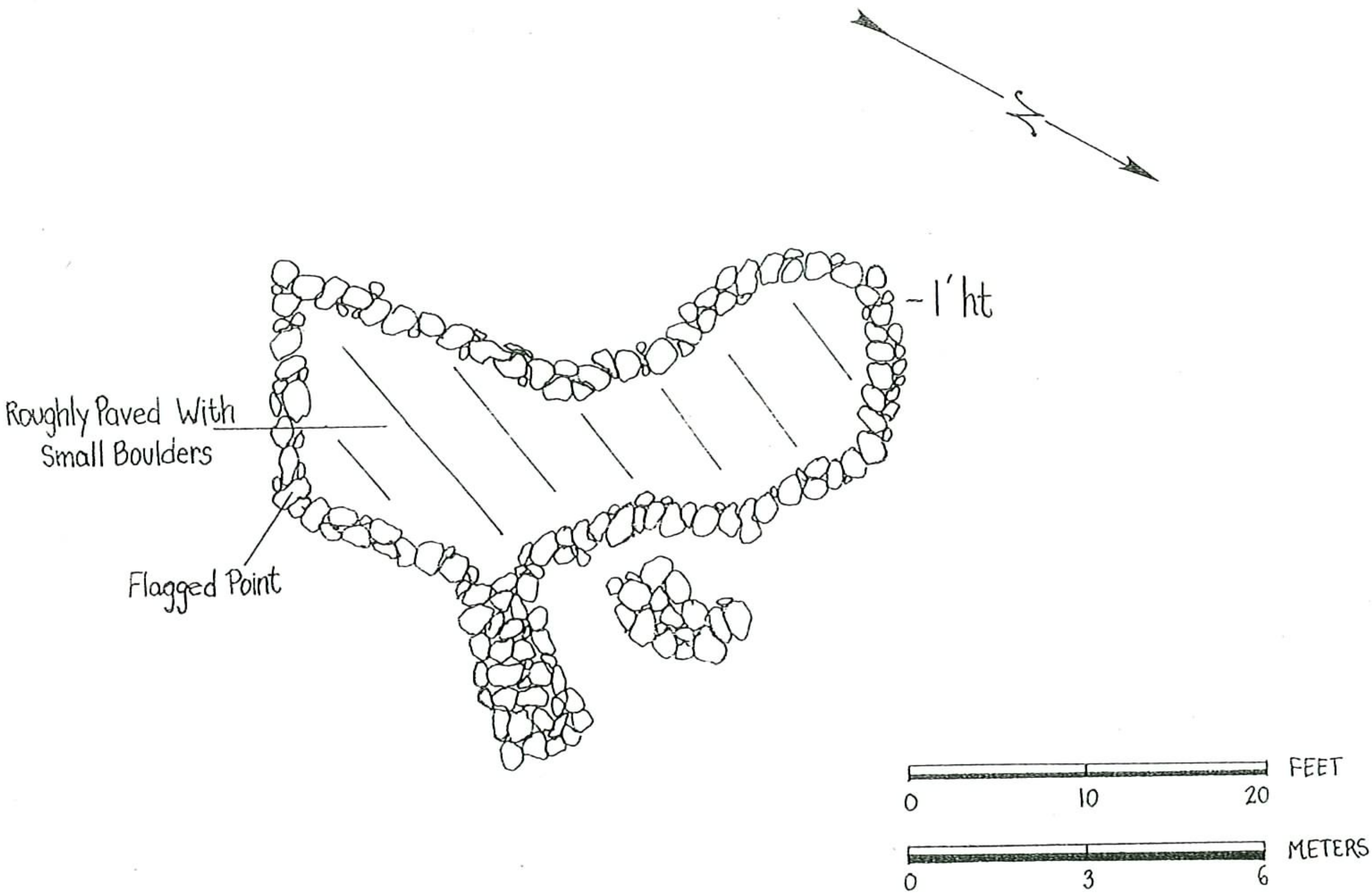

Fig. 12 State Site 914, Platform Plan View

crop. No midden or artifacts were observed. This is a pre-historic agricultural site.

State Site 917

Description (Fig. 13):

This is a U-shaped mound or rough platform measuring a maximum of 58' (17.7 m.) N/S and 34' (10.4 m.) east/west. The structure stands 1.5' to 2' (.5-.6 m.) above the surrounding terrain and has no distinct facing. The top surface is roughly paved with small boulders with two areas of soil and loose rock, one at the west end and one at the south end. This is only a possible habitation feature and shows no visible artifacts or midden. It is estimated to be a pre-historic agricultural site.

State Site 918

Description (Fig. 14):

This site consists of a well-defined, rectangular, permanent habitation platform measuring 15' (4.6 m.) E/W by 32' (9.8 m.) N/S and 1.5-2.5' (.5-.8 m.) high. The edges are faced with boulders and the top surface is paved with boulder slabs, cobbles, and compacted soil at the south end. At the northern end of the platform is a crypt-like depression measuring 2.5' (.8 m.) N/S by 8' (2.4 m.) E/W. Adjoining the main platform at the SW end is another smaller platform measuring 18' (5.5 m.) N/S by 12' (3.7 m.) E/W. This attached platform is 1' (.3 m.) lower than the main platform and is more roughly paved with small boulders and

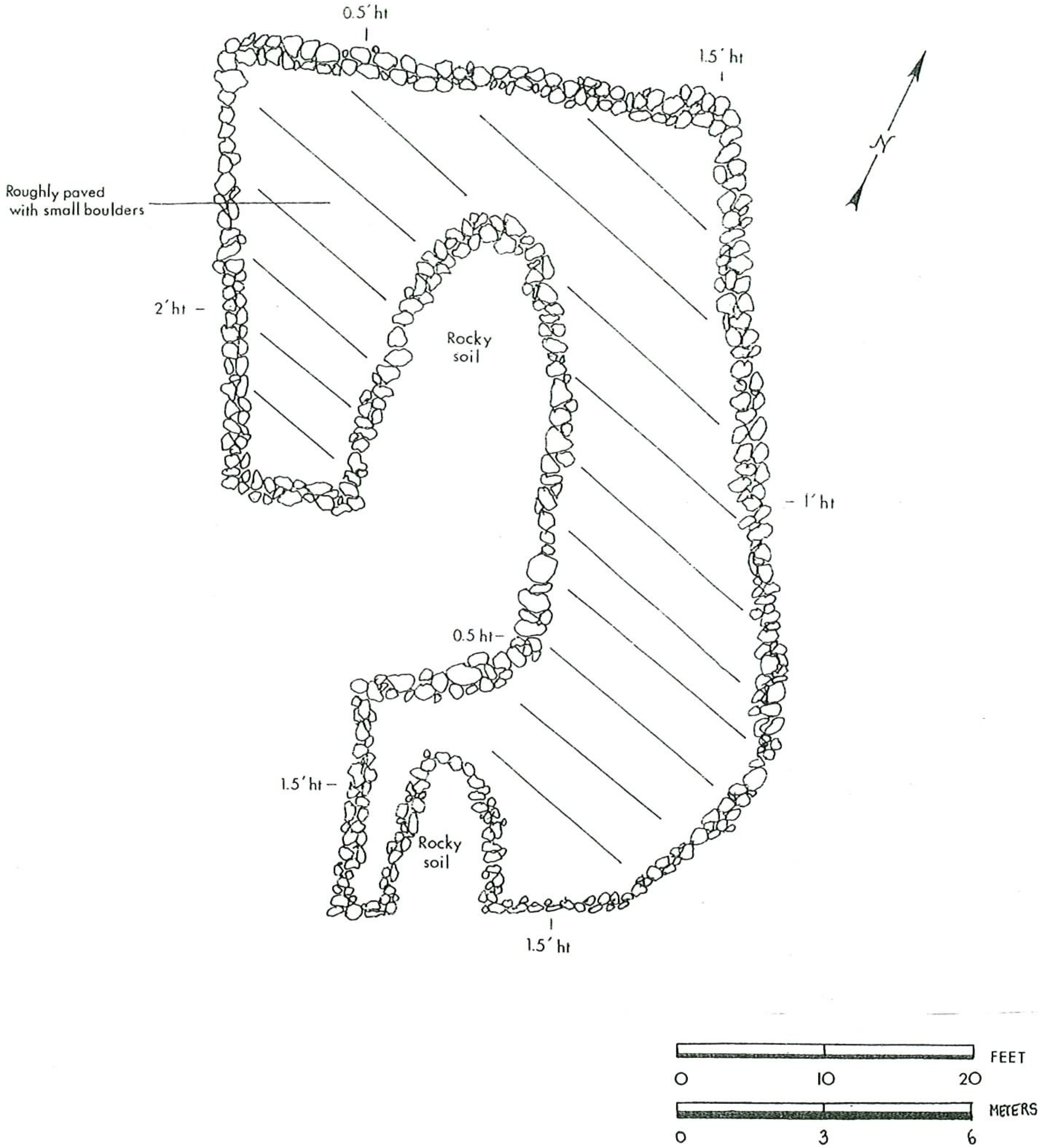

Fig. 13 State Site 917, Plan View

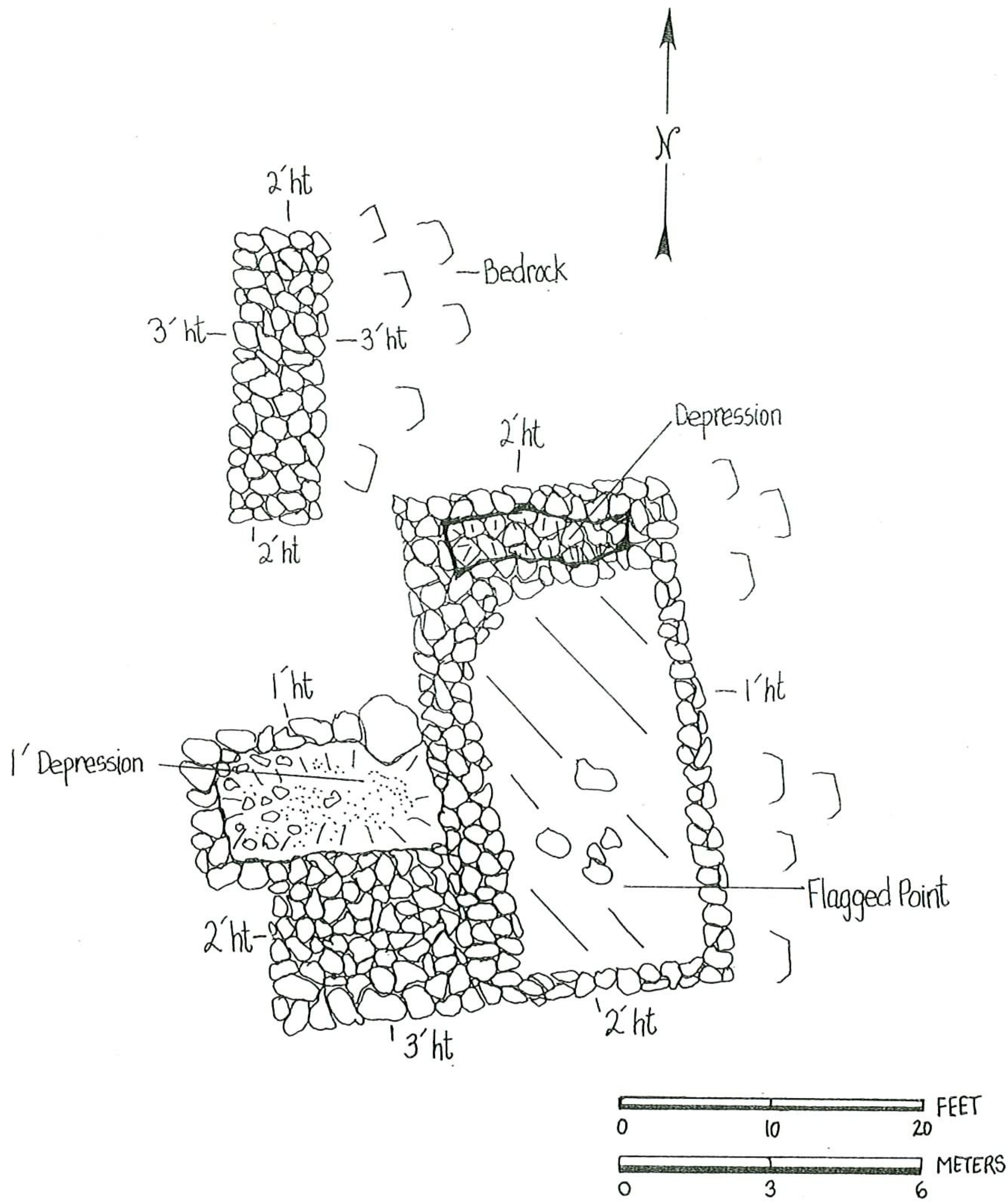

Fig. 14   State Site 918, Platform Plan View

cobbles. This platform stands approximately 1′ (.3 m.) high and contains soil at the north end. A 17′ (5.2 m.) long wall 5′ (1.5 m.) wide and 3′ (.9 m.) high runs N/S to the NW of the main platform. A few basalt flakes were observed on the surface of the main platform. This site is certain to be a focus of permanent habitation and probably contains a quantity of cultural material. It is judged to be pre-historic with early historic usage based on comparisons to other similar features in Kōloa, west of Waikomo Stream. Sites 1944A and B in the Kukuiula project area are of comparable size and have a similar soil and pebble paving and were determined to have been early historic habitations. This site, based on this comparison, may be of a similar time period.

State Site 919

Description (Fig. 15)

This site is a large paved and modified area on a low rocky bluff. It is a probably a temporary habitation site and possible burial consisting of a roughly triangular paved modified area with maximum dimensions of 78′ (23.8 m.) E/W by 86′ (26.2 m.) N/S. There are no clearly marked facings along the edge and the boundaries are poorly defined, merging with the surrounding rocky bluff. However, there are 2 well-defined interior features which include a rectangular hearth or small cupboard measuring approximately 2′ by 3′ (.6 by .9 m.) and 1′ (.3 m.) deep and defined by set uprights. To the east of this is a rectangular

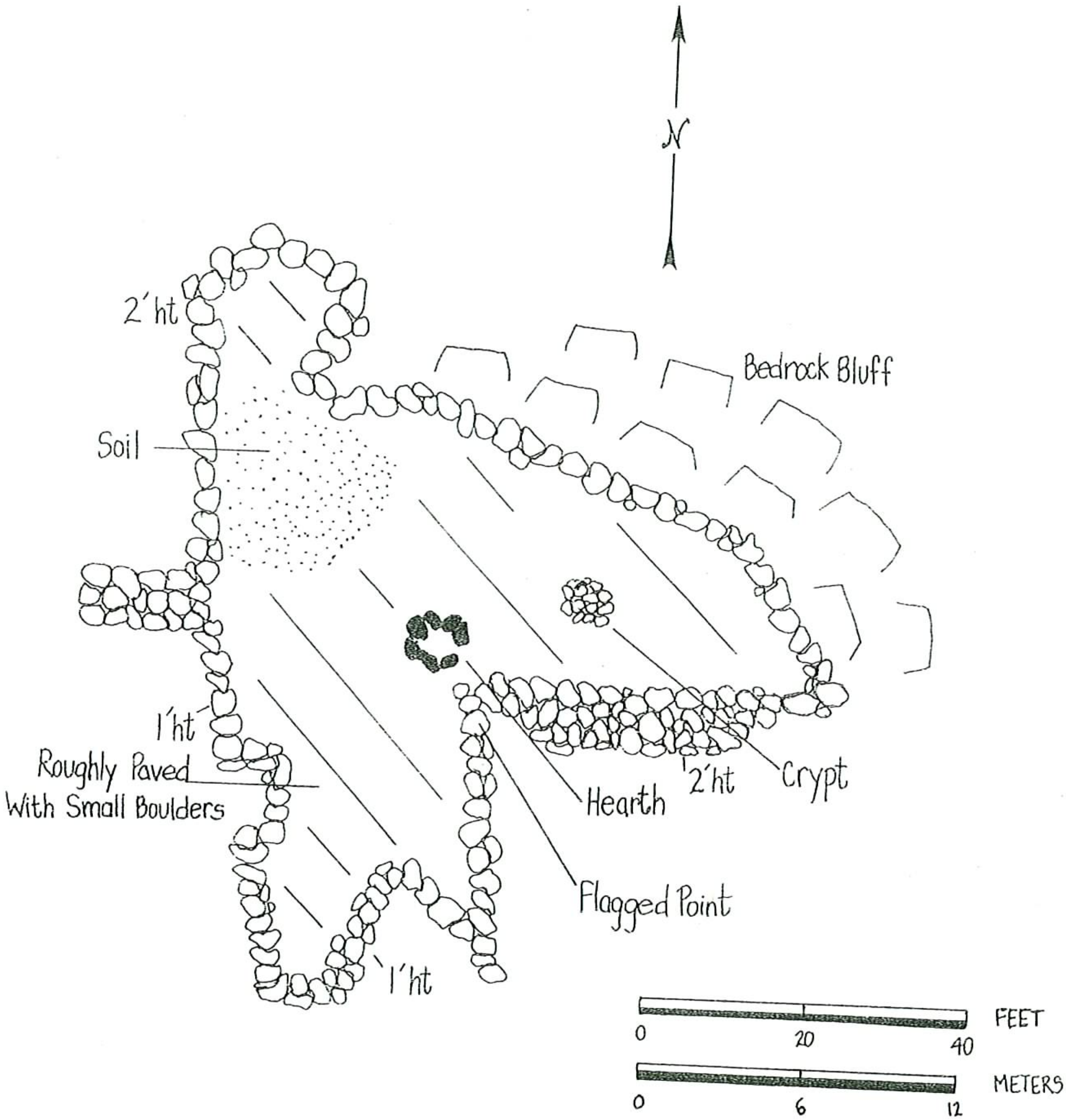

Fig. 15 State Site 919, Platform Plan View

alignment of set vertical stones on the site of a rectangular depression. The depression is 4' (1.2 m.) E/W by 2' (.6 m.) N/S and 2' (.6 m.) deep. The depression is lined with boulders. This site lies approximately 100' (30.5 m.) east of State Site 913 _'auwai_. No artifacts or midden were observed. The crypt on the east side is a possible burial feature. This is estimated to be a pre-historic site.

State Site 920

Description (Fig. 16):

This is a section of _'auwai_ which is oriented roughly N/S located approximately 100' (30.5 m.) east of Site 919. The _'auwai_ is best preserved at this locality for approximately 20′ (6.1 m.) but is traceable south for 60' (18. 3 m.) at 150° and north for 80' (24.4 m.) at 335° which mark the terminal points of the site beyond which there is no traceable _'auwai_ because of bulldozing. The _'auwai_ is defined by rock pilings on both sides and is 2.5' (.8 m.) wide at the base of the depression and 4' (1.2 m.) wide at the top. This is a pre-historic _'auwai_ with possible historic use for sugar irrigation.

State Site 921

Description (Fig. 17):

This is a poorly preserved section of _'auwai_ defined by a rock piling with a depression in the center. The depression in

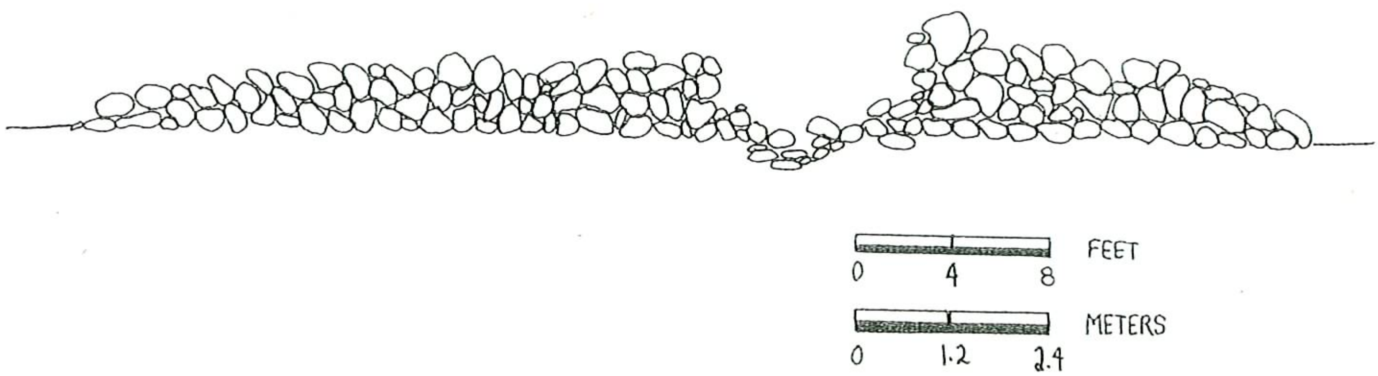

Fig. 16 State Site 920, '<u>Auwai</u> and Cross Section

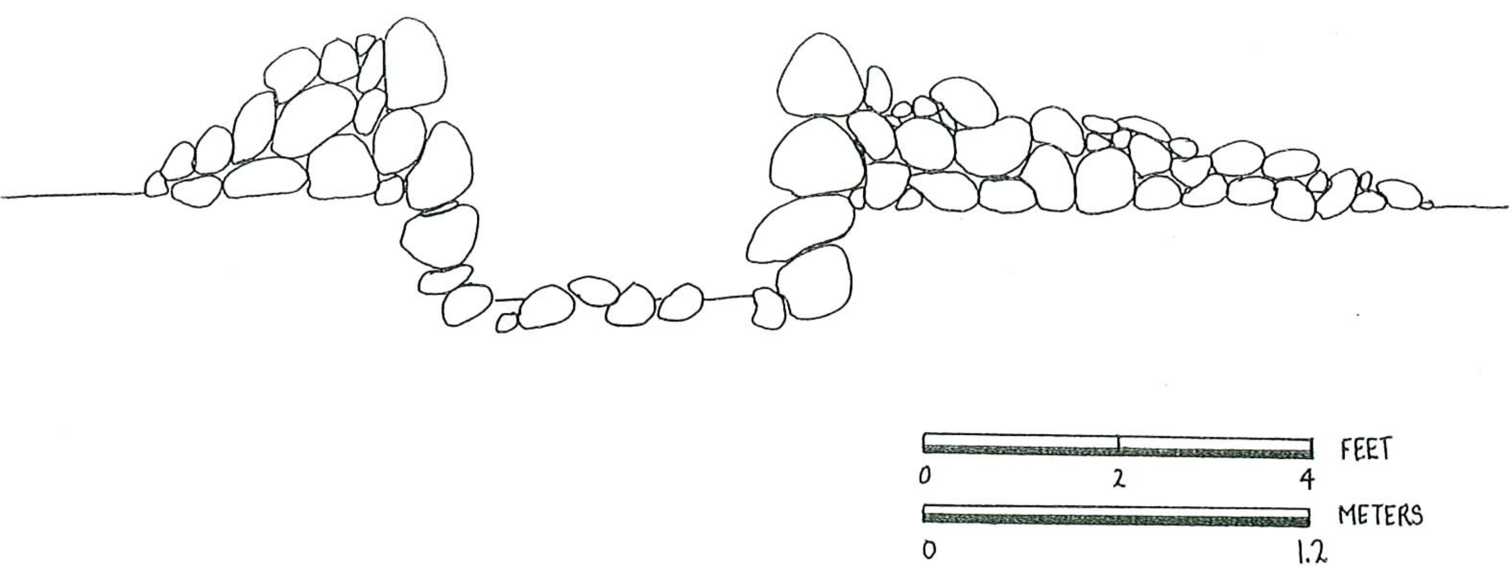

Fig. 17 State Site 921, '<u>Auwai</u> and Cross Section

this section is 2' (.6 m.) high and 2.5' (.8 m.) wide. The _'auwai_ is best preserved at this locality but is traceable for 140' (42.7 m.) north at 346° and south for about 100' (30.5 m.) at 155°. Over most of its length it has been filled in or modified by bulldozing. An L-shaped agricultural mound lies directly to the east of the _'auwai_. Because of bulldozing on both ends of the site, it is not traceable beyond these points and cannot be projected to connect to other _'auwai_ remnants. This is a prehistoric _'auwai_ with probable historic use for sugar irrigation.

State Site 922

Description:

This is an _'auwai_ section which is defined by a stone-lined linear depression. The _'auwai_ is approximately 1' (.3 m.) deep and 2.5' (.8 m.) wide and runs _makai_ from Site 932 for approximately 120' (36 m.). The _'auwai_ is traceable for a total distance of 750' (225 m.), oriented roughly N/S and at the north end it is oriented northeast to southwest. This _'auwai_ irrigated the small fields at Site 932. It is pre-historic, but may have been used for historic sugar cultivation.

State Site 923

Description (Fig. 18):

This site consists of a series of wall sections, one of which incorporates a small U-shaped shelter. The _makai_ most

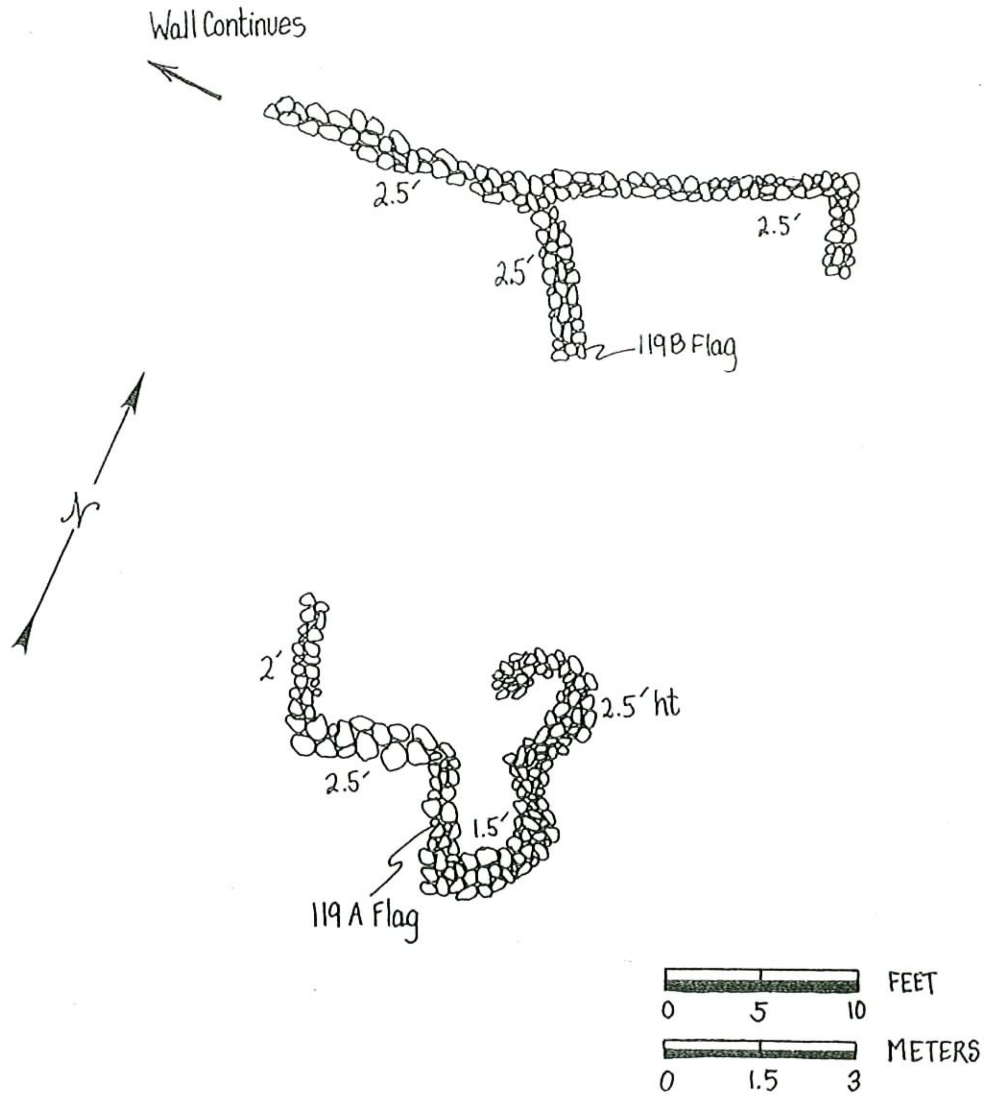

Fig. 18 State Site 923, Enclosure and Wall Section; Plan View

feature, A, consists of a wall curving around the makai edge of a low bluff. The wall is free-standing and curves for a length of approximately 40′ (12.2 m.). The wall averages 2.5′ (.8 m.) in width and stands a maximum of 5′ (1.5 m.) high at the makai end. At the northeast end the wall forms a U-shaped curve forming a probable small, temporary habitation shelter. The wall of the shelter is a maximum of 2.5′ (.8 m.) high and 3′ (.9 m.) wide. The interior dimensions are 2′ (.6 m.) E/W by 3′ (.9 m.) N/S. No midden or artifacts were observed on or near the shelter. This is estimated to be a pre-historic feature.

Feature B consists of an E/W oriented wall which averages 2.5′ (.8 m.) in height with a maximum of 3′ (.9 m.) in height and 3′ (.9 m.) in width. This wall has a length of approximately 150′ (45.7 m.) oriented at 90° (True north) and is terminated by bulldozing disturbance at both the east and west ends. It is a probable historic cattle wall postdating traditional wetland agriculture in the area. This age is indicated by the fact that it corresponds to the northern edge of the Kōloa Sugar field. It probably functioned as a wall to keep cattle out of the fields.

Feature C is an eastward extension of Feature B wall separated by a 60′- (18.3 m.-) break in a bulldozed area. This probable cattle wall extends westward for 100′ (30.5 m.) at 92° True, then northeastward for 50′ (15.2 m.) and then corners eastward for approximately 120′ (36.6 m.) where it is cut by bulldozing.

State Site 924

Description (Fig. 19):

This site is a N/S oriented mound standing at a maximum height of 3.5' (1.1 m.) and averaging 8' (2.4 m.) wide and oriented 320° TN running NW/SE approximately 30' long. In the NE end is, incorporated into this mound, a well-constructed C-shaped shelter, the interior of which measures 8' (2.4 m.) N/S by 6' (1.8 m.) E/W. The east wall of the shelter is well-constructed with a lower course of vertical uprights. As the wall rises upwards, it curves inward, creating a corbelled effect.

The mound extends another 20' (6.1 m.) southward from this C-shape and the east wall of the mound is well constructed with some vertical facing averaging 2.5' at the north end, sloping downwards to 1' high at the south end. There is a slight inset in the east face opposite the south end of the C-shape shelter with vertical facing. This mound and C-Shape shelter probably originated as an agricultural clearance mound and, as the mound was added to, the C-shape was built on the west end of it. It is generally a well-constructed site, particularly in the interior of the shelter, although there are many collapsed rocks on the east wall. It has some excavation potential as there is some soil deposit. No midden or artifacts were observed in or near the site. This is a temporary shelter site of pre-historic age.

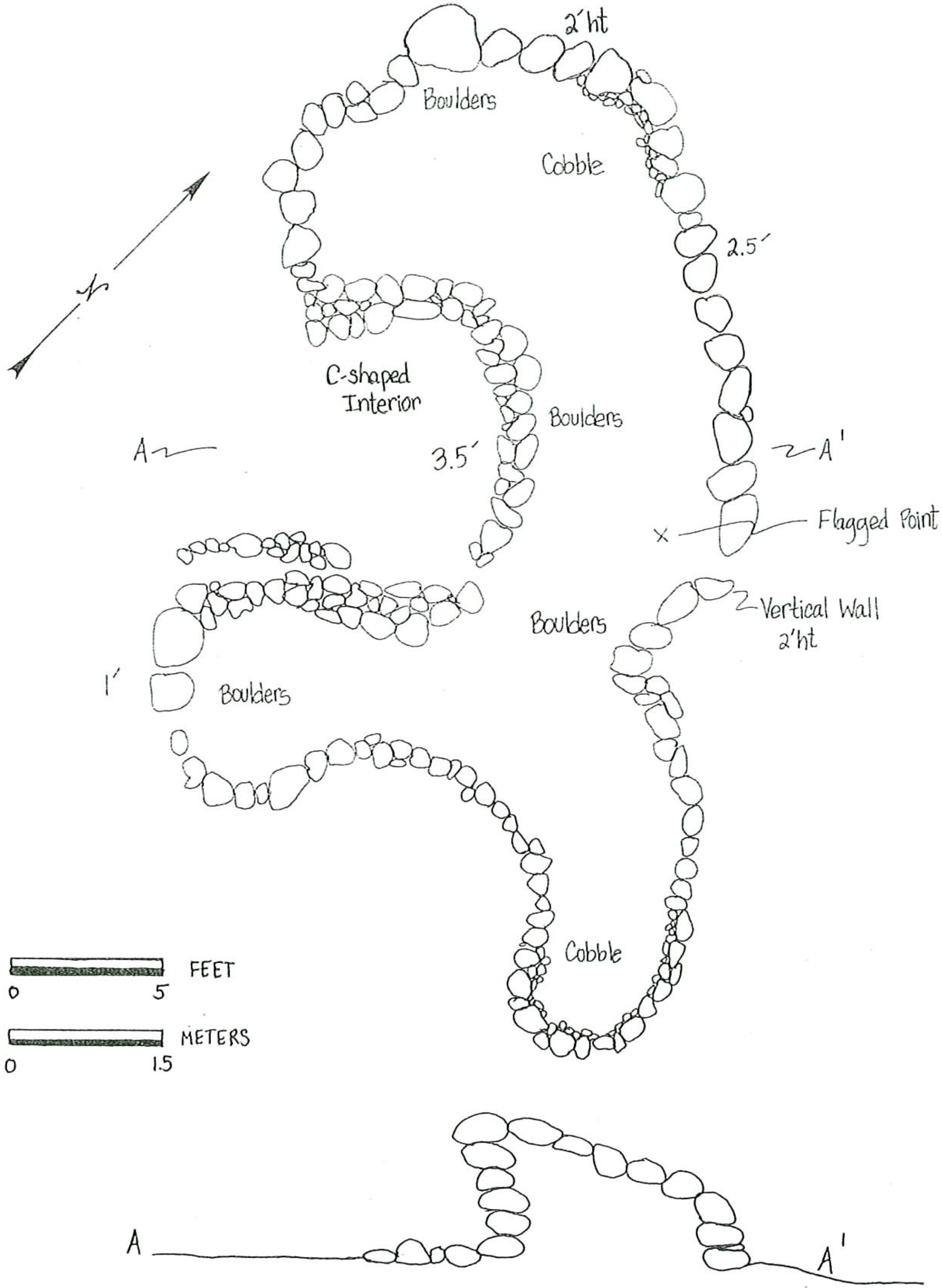

Fig. 19 State Site 924, C-shaped Shelter; Plan View and Cross Section

State Site 925

Description (Fig. 20):

This is an enclosure site for temporary habitation, the interior of which stands 1-1.5' (.3-.5 m.) above the surrounding terrain. It is on a definite rise, which is probably fill on top of a low bedrock bluff. The long axis of the enclosure is N/S. It appears to be a habitation enclosure. The interior dimensions are E/W 6-8' (1.8-2.5 m.), N/S 10' (3 m.). The north/northeast and east walls stand at the interior an average 1' (.3 m.) high and on the exterior 1.5 - 2' (.5-.6 m.) high. The walls are 6-7' (1.8-2.1 m.) wide with a lot of collapse, built of piled boulders.

The walls are intact on the north side; on the west side they are partially broken down averaging 4-5' (1.2-1.5 m.) wide; there's a opening in the northwest corner and the south end which appears to be broken down as well by cattle. Here the walls stand less than 1' (.3 m.) high. The wall alignments show the walls were originally 3' (.9 m.) wide before collapse and at the south end have some core filling. The interior of the enclosure is rock, boulders with some scattered appearance of paving. No midden or artifacts are visible. The long axis of the site is oriented 350° TN. The NE portion of the interior has a slight inset which may be a small paved area which is an extension of the exterior wall of the site. Other than that the site is a uniformly well-shaped rectangle. It is estimated to be a prehistoric site.

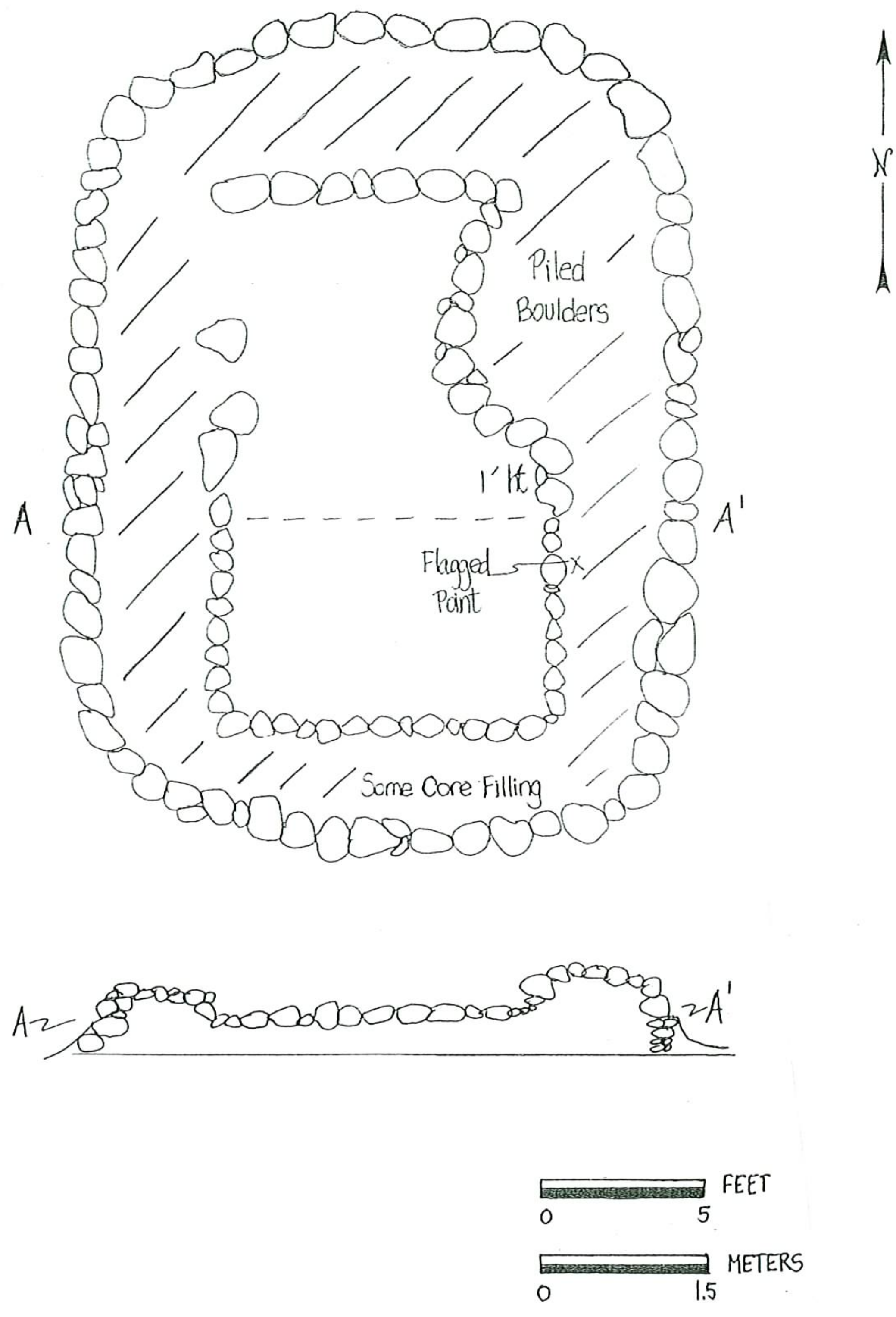

Fig. 20 State Site 925, Enclosure; Plan View and Cross Section

State Site 926

Description of Features A-G (Fig 21):

State Site 926 Feature A consists of an enclosure which is built into the S side of a large cattle corral north of Site 926 flag. The feature consists of a continuous enclosing wall, enclosing an area measuring 6' (1.8 m.) E/W, 4' (1.2 m.) N/S. The walls average 3' (.9 m.) in thickness and are 3' (.9 m.) high. There is a thick wall on the W side which measures 5' (1.5 m.) in width and 3' (.9 m.) in height and the wall continues to the E and the W. The E wall measures 4' (1.2 m.) high and 2.5' (.8 m.) wide. This is a probable older habitation or shelter feature which has been incorporated into a modern cattle corral wall. Excavation potential appears to be minimal. The interior of the enclosure is rock and has very little soil deposits. No midden or artifacts are visible on the surface, in the walls, or in the interior of the structure.

State Site 926 Feature B is a large cattle corral consisting of a walled enclosure 120' (36.6 m.) E/W and 120' (36.6 m.) N/S. On the NW side are 3 gates and on the SE side one gate, making a total of 4 gates. The cattle contains a water trough and presently contains about 30 head of cattle. Most of the walls of the corral are 3' (.9 m.) wide and 4-5' (1.2-1.5 m.) high. Of note is the eastern wall of the corral, which is unusually wide. It is a core-filled wall, 6' (1.8 m.) wide and 4' (1.2 m.) high. The interior of the corral is mostly bedrock with thin soil cover and liberal covering of cow manure. This is a modern feature which may incorporate some older walls, particularly the eastern wall previously mentioned. At the NW corner of State Site 926 Feature B is a remnant of an 'auwai that runs along the east side of a low crumbled wall. This 'auwai is traceable mauka approximately N/S and runs between State Sites 937 and 941. It appears on the State Site 940-941 map.

State Site 926 Feature C is another enclosure which adjoins Feature B to the SW. It is a smaller walled enclosure measuring 60' (18.3 m.) E/W x 70' (21.3 m.) N/S and an irregular oval shape. The N wall of this enclosure is the same as the SW wall of the corral Site 926 Feature B. This particular enclosure has intact walls on the E, W and S sides and may be an older cattle corral or may be an older remnant of an agricultural wall. There is no sign of an 'auwai entering the enclosure, but it is probably an agricultural feature -- a walled field -- and the interior of the enclosure is a thick soil deposit. No artifacts or midden are visible within the enclosure or within the walls.

State Site 926 Feature D is located 6' (1.8 m.) to the W of the SW corner of Feature B, the modern corral. Feature D consists of a 8' (2.4 m.) square mound, the makai or south portion of which is a partially standing mortared wall. This site is in very poor condition; however, it appears to be the remnant of a crypt or possibly an historic bread oven. There are red bricks distributed on the surface around this mound. There are plentiful mortar pieces and the top portion of the mound is scattered with sandy decayed mortar and soil. This is clearly a historic era feature, either a burial crypt, or, and more likely, the very poorly preserved remnant of a bread oven.

State Site 926 Feature E is a rectangular enclosure measuring 40' (12.2 m.) E/W by 20' (6.1 m.) N/S. The walls incorporate large boulders as the lower course with some uprights averaging 2' (.6 m.) high. The W side is 2.5' (.8 m.) high with large boulders. The north side is partially collapsed, 3-4' (.9-1.2 m.) wide. The E side incorporates large uprights and is core filled. If there is an entrance in this enclosure it is located in the SE corner. This is a probable agricultural enclosure, enclosing a field system. The interior is rocky, with some soil cover and it appears to be a closed field or possibly a former animal pen.

Examination of the N wall of the enclosure shows a core-filled wall standing 2' (.6 m.) high max. which averages 8' (2.4 m.) in width;it includes some collapsed portions and 2 very visible alignments of rocks on either side, with a small cobble and soil fill in the interior. This looks like a typical field wall that has been incorporated into the enclosure of Site 926, Feature E.

State Site 926 Feature F is an <u>'auwai</u> which runs E/W along the NW portion of the Site 926 complex. The <u>'auwai</u> is defined by 2 parallel rock mounds 4' (1.2 m.) apart with a 2' (.6 m.) deep depression in the center. The <u>'auwai</u> is traceable in an E/W direction for 100' (30.5 m.) and at its east end probably connected to the <u>'auwai</u> entering the complex from the north although the point of connection at the NW corner of Corral Feature B has been disturbed by bulldozing.

State Site 926 Feature G is a small habitation or shelter feature. It is an enclosure, roughly oval-shaped, built on a piled boulder mound which probably originated as a field clearance mound. The mound stands approx 3' (.9 m.) above the surrounding ground surface and measures 23' (7 m.) N/S x 15' (4.6 m.) E/W. The interior of the shelter enclosure measures 13' (4 m.) N/S by 6' (1.8 m.) E/W. The walls around the enclosure are fairly intact on the east side standing in the interior approximately 1.5-2' (.5-.6 m.) high; they have some uprights in the lower course. There is some collapse of these walls but they are fairly intact on the E and S sides. The walls average 3-4' (.9-1.2 m.) in width. The W wall is collapsed and stands 1' (.3 m.) or less high. The N wall is very low and discontinuous. The feature is probably a shelter. The E wall, which would be the windward, is considerably thicker and higher than the other walls. This is a probable prehistoric shelter site associated with the surrounding fields and there are no artifacts or midden visible on the surface. The interior consists of thin soil and collapsed boulders from the walls. The excavation potential is fair. There could be occupation debris within the interior. This feature is located W of the field system of State Site 926.

In summary, State Site 926 consists of numerous boulder walls, core-filled and mounded walls, comprising the boundaries of the agricultural fields from the late prehistoric and early historic times. Some of the fields form enclosures, such as Features 926E, C and B. The NE portion of the complex is a modern corral, described as Feature 926B. To the W and SW are various field walls and fields comprising the prehistoric and early historic field system. The fields are mostly soil, have been cleared of rocks; the walls tend to be thick, sometimes 5-6' (1.5-1.8 m.) thick and many of them are core filled, indicating the early clearing of the larger rocks to make the boundaries of the walls, and then the later clearing of the smaller rocks to provide the core filing of the walls. At the NW end of the complex is an 'auwai, which consists of 2 parallel mounded walls. There is a modern water pipe running through the center of the 'auwai. The 'auwai is traceable for approximately 100' (30.5 m.) and runs approximately E/W to connect to the N/S 'auwai. There are other stacked boulder walls, some of which may be cattle walls, specifically cattle-excluding walls to keep the cows off the fields. The other walls are clearly field clearance walls and are not for excluding cattle, since they are only 2-3' (.6-.9 m.) high but quite thick.

This is a remnant of a former irrigated field system modified by historic ranching. Although the 'auwai route through the fields is not traceable, an 'auwai connects to the system from the north and exits to the south east.

This site, which was mapped on a scale of 1" = 50' (2.54 cm = 15.2 m.), extends approximately 400' (122 m.) E/W and approximately 350' (106.7 m.) N/S. It extended far beyond these limits

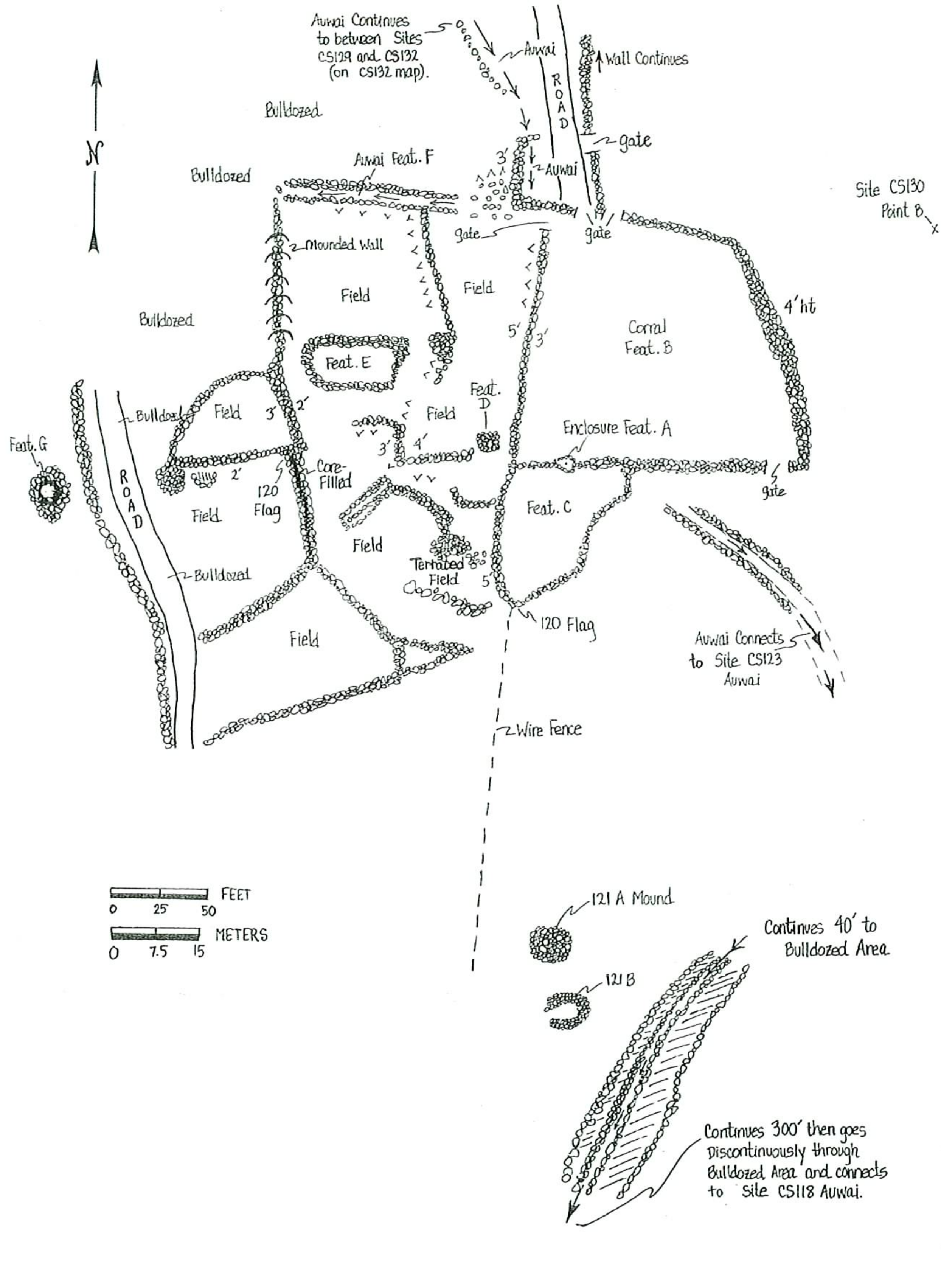

Fig. 21 State Site 926, Corral and Agricultural Complex; Plan View (also showing States Sites 927-929)

at one time but the areas around this mapped field system have been bulldozed and only very short, badly disturbed remnant walls survive outside this core area. Historic activity is indicated by the scattered metal pieces, fencing spacers, branding irons, and metal buckets associated with the modern ranching era. In addition, State Site 926 Feature D, is a brick and mortared stone structure of unknown function, but is evaluated at present to be a former oven or a burial. The only clearly defined prehistoric or early historic habitation feature is a small habitation enclosure which is State Site 926 Feature G at the W end of the complex. All other enclosures are probably fields, for instance E and C, and are related to agriculture. This site is correlated to LCA 3601 whose boundaries include most of the eastern portion of the site. The testimony for the LCA mentions 3 lo'i but with the present configuration of the site it is difficult to determine which 3 lo'i are referred to. There is no mention of a house lot but one is shown on the Monsarrat map (Fig. 5). No trace of this house site was seen on the ground.

State Site 927

Description (Fig. 21):

State Site 927 is well constructed mound feature which measures 14' (4.3 m.) N/S x approximately 17' (5.2 m.) E/W. The top surface of this feature is mounded with no apparent paving. There is a surface of piled boulders and large cobbles. The E side of the structure appears to have a rough facing which stands

2' (.6 m.) high. The mound generally stands 2-2.5' (.6-.8 m.) above the surrounding terrain. The NW and S sides are not well defined and do not have visible facings. The NE and SE corners are rounded. This site is a probable agricultural mound but because of it size and appearance as a more formal structure it is recorded as a possible burial and should be tested to determine its function. It is estimated to be of pre-historic age.

State Site 928

Description (Fig. 21):

State Site 928 is 32' (9.8 m.) to the SE of State Site 927 mound. State Site 928 is a very low, doughnut shaped stone pile measuring 23' (7 m.) N/S by 20' (6.1 m.) E/W. The walls have been collapsed and probably run over by a bulldozer at least once. The interior, which is relatively rock free, measures 8' (2.4 m.) E/W by 4' (1.2 m.) N/S. There is a remnant of an alignment on this pile at the E end of the structure which may have formed the interior alignment of a former shelter site. This particular feature is in very poor condition and unrecognizable as any particular form of site in its present condition but it may have been a C-shaped shelter whose walls have collapsed both inward and outward. Its excavation potential is very low. No midden or artifacts are visible on the surface. This site is of very low value but is recorded because it is a site remnant and a possible prehistoric temporary shelter site. It is a typical, but badly damaged, pre-historic structure similar to other pre-historic C-shapes in the project area, all of which are shown to be pre-historic from previous testing (Hammatt, 1985). This is a pre-historic site that was probably used for sugar irrigation in historic times.

State Site 929

Description (Fig. 21):

State Site 929 'auwai: This 'auwai is 49' (14.9 m.) to the E of State Site 927. It consists of an 'auwai which is approximately 2' (.6 m.) in depth and averages 2-3' (.6-.9 m.) wide. It's defined by 2 parallel linear rock mounds. On the W side the mound stands 1' (.3 m.) high and 4-6' (1.2-1.8 m.) wide and on the E side the mound is 2' (.6 m.) high and 8-10' (2.4-3 m.) wide. The 'auwai is traceable to the SW for 300' (91 m.) and then is bulldozed, but can be traced discontinuously through the bulldozed area for 400' (120 m.) to the south which is on the other side of a wire fence. To the NE the 'auwai is traceable for 40' (12.2 m.) at an angle of 40 degrees to a bulldozed area. This 'auwai was at one time a branch of the State Site 930 'auwai but the connection is no longer traceable. This is a pre-historic site which was probably used for sugar cultivation in historic times.

State Site 930

Description:

State Site 930 is an _'auwai_ to the E of 929 _'auwai_. The _'auwai_ is oriented 154° moving SE and 357° (moving almost straight N). It is traceable to the N of the Site flag for approximately 80' (24.4 m.) and to the SE for 60-70' (18.3-21.3 m.) where on both sides it is interrupted by bulldozed areas. To the SE is a large open field, which is almost certainly a former sugar field. The _'auwai_ is similar to State Site 929 but is less well preserved. It consists of 2 parallel linear mounds with the depression in the center measuring 2-3'(.6-.9 m.) wide and a maximum of 2' (.6 m.) from the top of the mound to the base of the _'auwai_. No clearly visible stone alignments remain and the _'auwai_ is in poor condition. An attempt was made to trace it to another recorded _'auwai_ to the S but the area has been bulldozed. The _'auwai_ is traceable northwards only to a bulldozed area but badly disturbed remnants of it are traceable northwards and northwestward to the _'auwai_ at the S central portion of State Site 926 Feature B. This is a pre-historic site which was probably used for sugar cultivation.

State Site 931

Description:

This is another _'auwai_, which again is defined by 2 rough, linear parallel mounds which crest to crest are approximately 10' (3 m.) apart. The _'auwai_ itself is a depression in between these

2 linear mounds and measures 2-3' (.6-.9 m.) wide and 2' (.6 m.) high from the crest of the mounds to the base of the _'auwai_. The _'auwai_ is oriented 342° NW to SE. To the SE it ends in a large open field which is presently used as pasture and has been bulldozed many times. To the NW it is traceable for approximately 60-70' (18.3-21.3 m.) continuously and extends discontinuously across bulldozed areas connecting to State Site 938 _'auwai_. This is a pre-historic site which was almost certainly used for sugar cultivation in historic times.

State Site 932

Description (Fig. 22):

This agricultural and possible temporary habitation complex adjoining an _'auwai_ (Site 922) running _makai_ on the E side of a stone wall. The wall and _'auwai_ are traceable N/S for approximately 220' (67 m.). Other low field walls run perpendicularly. The _'auwai_ is visible but poorly preserved and is bounded on the E side by a 1' (.3 m.) high dirt mound with a few rocks. The wall on the W side reaches a height of 3' (.9 m.) maximum and varies from 3' (.9 m.) to 6' (1.8 m.) wide. An enclosure State Site 932 lies adjacent to the _'auwai_ on the west side. It is a possible habitation feature measuring 25' (7.6 m.) in diameter in the interior. Walls are 2' (.6 m.) to 4' (1.2 m.) wide and 2' (.6 m.) high with a soil interior. A probable entrance lies on the north side. No midden or artifacts were observed. This is a probable prehistoric site which has survived surrounding bulldoz-

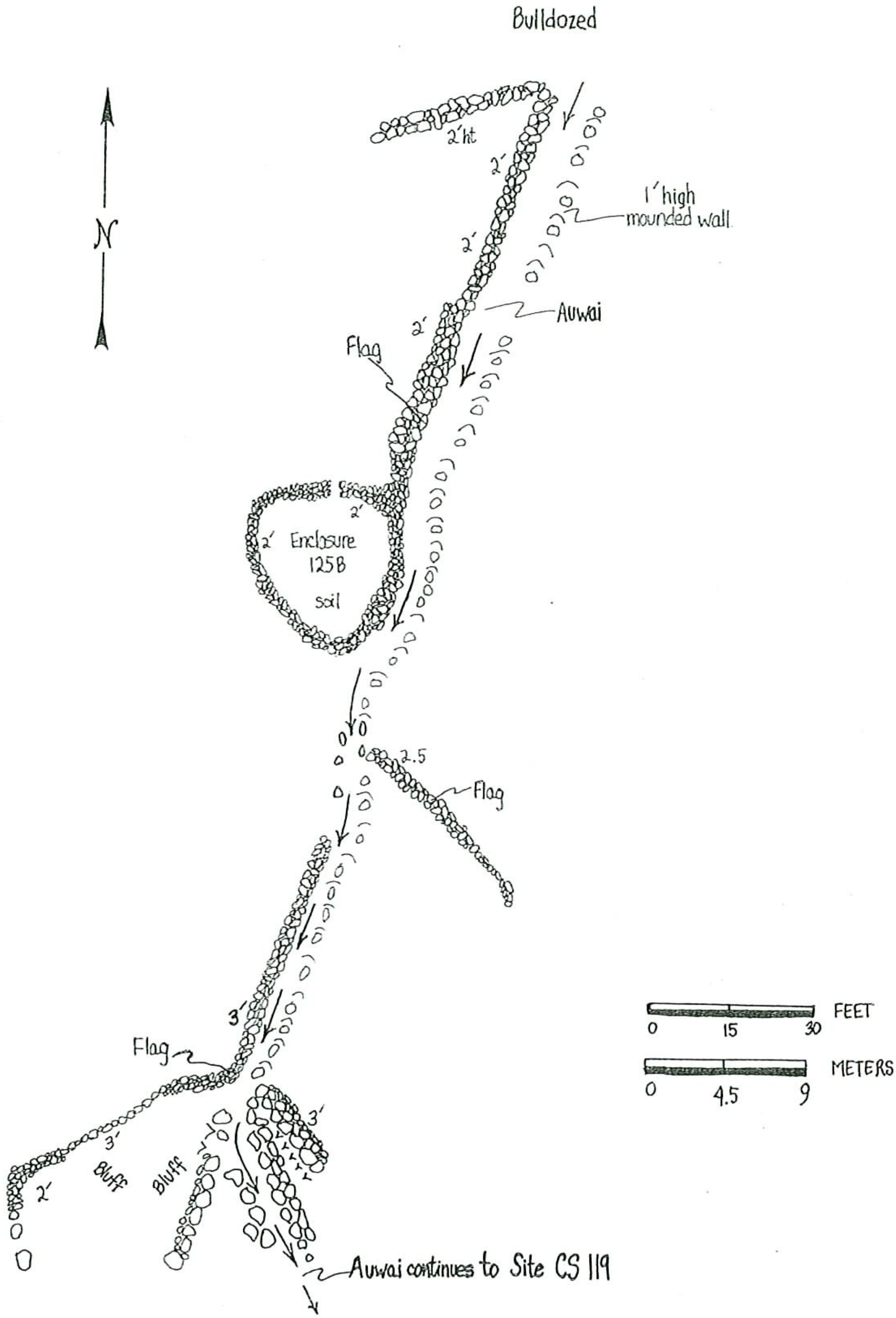

Fig. 22 State Site 932, Plan View

ing. Its walls and fields are typical of the pre-historic Kōloa fields found in Kīahuna and Kukuiula.

State Site 933

Description:

State Site 933 Feature A is a wall segment on the W side of a bulldozed road which forms an L-shape. The long axis of the L measures 56' (17 m.) long, 4' (1.2 m.) high and 8' (2.4 m.) wide (including collapsed sides)and is oriented N/S. The short wall measures 34' (10.4 m.) and curves to the SW measuring 2' (.6 m.) high and 3' (.9 m.) wide. This is a probable remnant of an agricultural field wall. It is in poor condition.

State Site 933 Feature B is a 10' (3 m.) long remnant of an 'auwai marked by two rock piles oriented 35°; it's in very poor condition and barely recognizable as an 'auwai. This 'auwai section lies 60' (18.3 m.) NW of Site 933A and NE of Site 932. Before bulldozing this 'auwai probably connected to the Site 932 'auwai. This is a pre-historic site which may have been used in historic times for sugar irrigation.

State Site 934

Description:

This site consists of a wall. The wall is oriented northeast and is 431' (131.4 m.) long with two 10' (3 m.) wide breaks from bulldozing. The wall is 5' (1.5 m.) high and averages 3' (.9 m.) wide at the base. It is a cattle wall constructed of stacked boulders and is in good condition. In sections remnants of older, wider core-filled walls can be seen at the base of this cattle wall indicating 2 styles of construction associated with 2 chronologically distinct land uses (planting and cattle ranching). Cattle walls are typically free-standing 4-5' (1.2-1.5 m.) high and constructed of stacked boulders. Older field walls are low, mounded and filled with soil and cobbles and follow the contours of the terrain to enclose level field areas. Both walls are represented here indicating pre-historic and historic construction.

State Site 935

This mound measures 16' (4.9 m.) E/W by 20' (6.1 m.) N/S; it is roughly oval shaped and stands approximately 1-5' (.3-1.5 m.) above the surrounding terrain. The upper surface is boulders and cobbles. No artifacts or midden were observed. There is a high probability of this being a pre-historic agricultural mound; there are no facings on the sides of the feature.

State Site 936

Description (Fig. 23):

This is a large mound of rocks piled on a bluff which is surrounded by open fields. The bluff stands 3' (.9 m.) above the surrounding terrain and is roughly oval in shape and measures 65' (19.8 m.) E/W by 40' (12.2 m.) N/S. The north side of the bluff

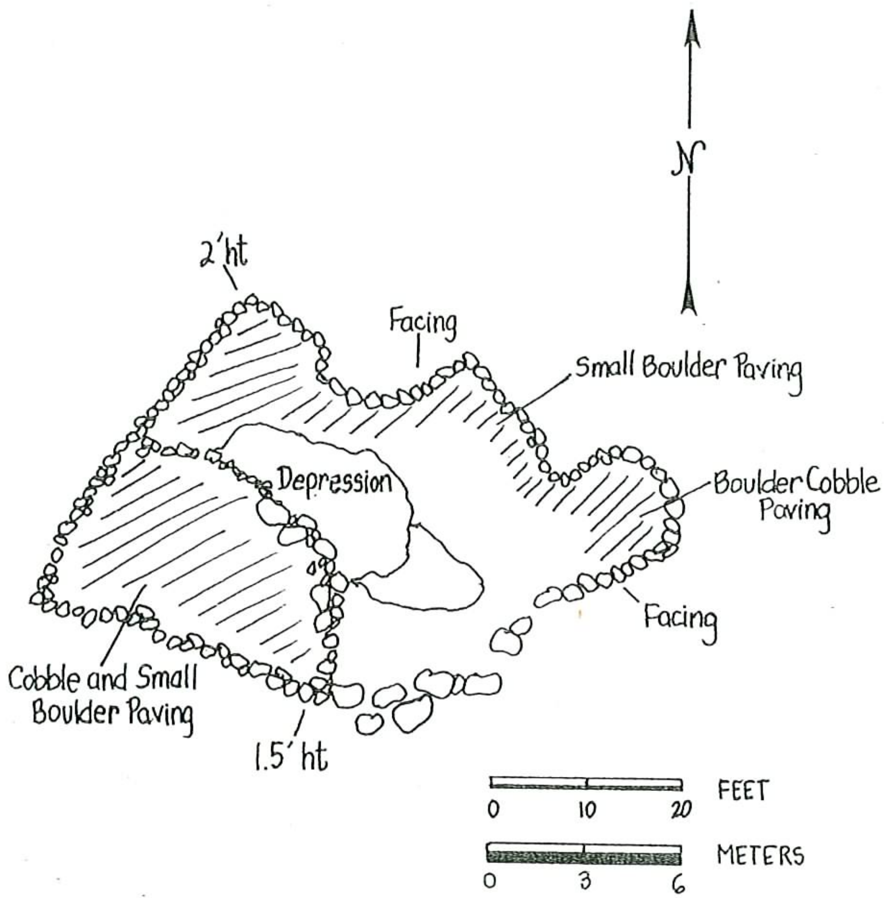

Fig. 23 State Site 936, Mound with Paving

has rough vertical facing with boulder paving around the edges. The south side is generally unfaced. On the west side is a fairly level area which is cobble paved measuring 25' (7.6 m.) E/W by 15' (4.6 m.) N/S. This paved area could have been used for habitation (or burial). No artifacts or midden were observed. This is an agricultural mound but was modified in places for other possible uses. Because of this modification (facing and paving) it is not a typical ag mound but the other uses are not clear from the configuration. Burial use is the most likely. This is a pre-historic site.

State Site 937

Description:

This is a well-constructed probable cattle wall which stands an average of 5' (1.5 m.) high and 3' (.9 m.) wide at the base. The wall lies northeast of Site 936 and extends south-
west 100' (30.5 m.) to a point at which there are 2 wall branche-s. One wall extends 54' (16.5 m.) southeast (125°) and ends; the other goes west (280°) for 30' (9.1 m.) and ends. The wall is in good condition at the north end and is well constructed. This is a typical cattle wall - i.e., free-standing, constructed of stacked boulders, 5' (1.5 m.) high; it does not define level areas of the typography but is constructed independent of slope. It is historic.

State Site 938

Description (Fig. 24):

State Site 938 consists of a wall which was traced for 550' (167.6 m.) within the project area but extends outside at both ends. This is one of the more substantial walls in the survey area. It incorporates very large boulders and is well-constructed along most of its length. It is 6' (1.8 m.) wide along most of its length and reaches a height of 6' (1.8 m.). The outside of the wall is well-stacked large boulders, with some vertical uprights. The interior of the wall is smaller rocks, small boulders and cobbles, and is core filled. To the east, within 1' (.3 m.) or 2' (.6 m.) of the wall, an 'auwai runs continuously parallel to the wall. The 'auwai is shallow, is poorly preserved, and is defined by 2 parallel rows of rocks. The 'auwai is less than 1' (.3 m.) deep and averages 2' (.6 m.) wide. At the S end of the wall, as the wall turns SE, the 'auwai runs through a tunnel in the wall. The tunnel is 2.5' (.8 m.) wide and 1.5' (.5 m.) high and runs 4' (1.2 m.) through the wall, which is also 4' (1.2 m.) thick. It is a post and lintel stone construction. The sides and the top are selected pahoehoe slabs. The wall partly encloses a large open field, identified on the 1918 Kōloa Sugar Co. Map (Fig. 6) as Field 4A, and the 'auwai appears to have been used in historic times as a cane field irrigation 'auwai. The presence of the tunnel through the wall shows the contemporaneity of the later phases of irrigation on this land and the construction of large cattle walls. The wall

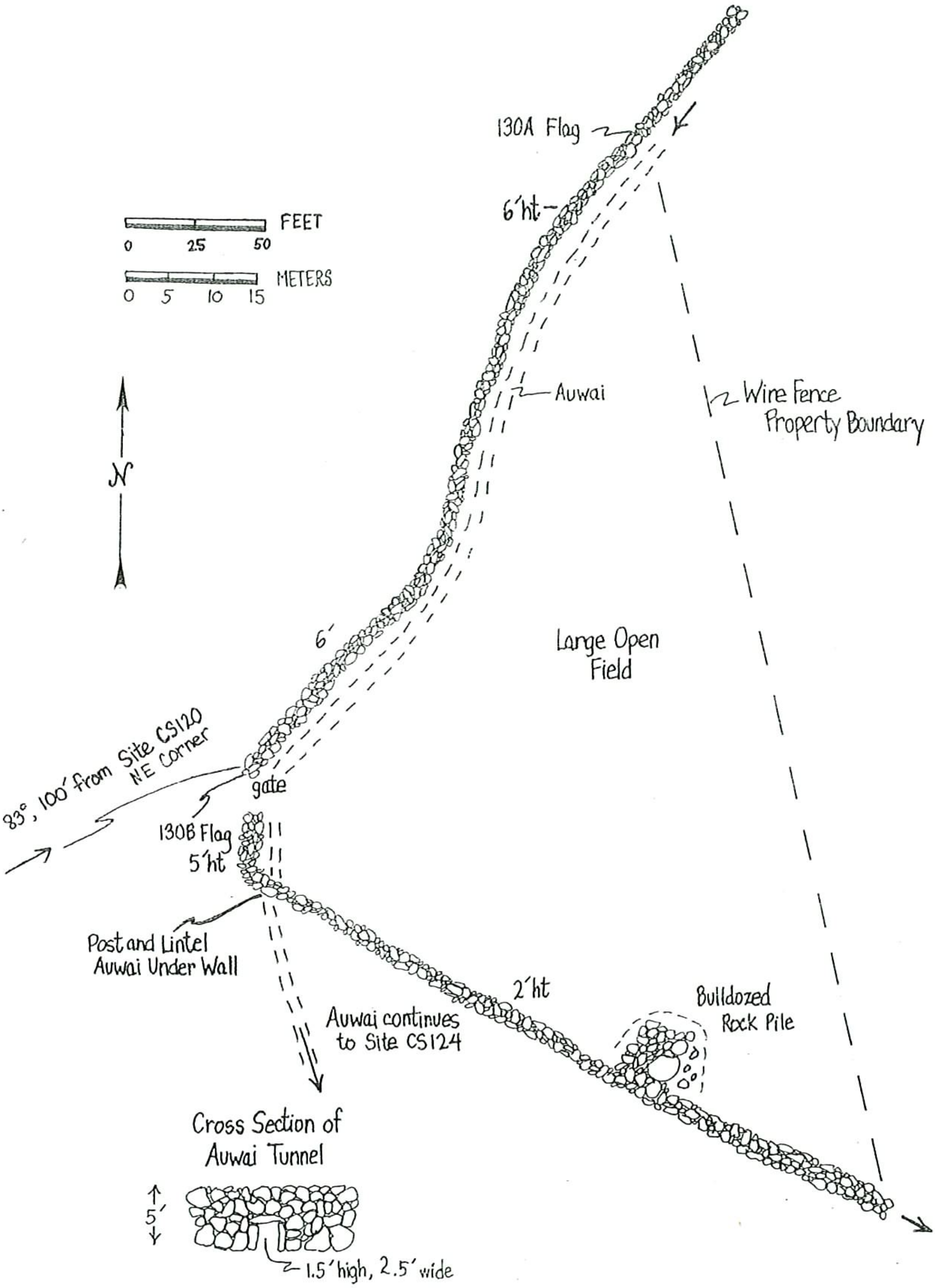

Fig. 24 State Site 938, Field Enclosure and <u>'Auwai</u> Plan View and Cross Section

is historic and the 'auwai may have been a pre-historic construction but was clearly used to irrigate the sugar field.

State Site 939

Description (Fig. 25):

This State Site 939 cave shelter has a west-facing entrance measuring 14' (4.3 m.) N/S and roughly 2-4' (.6-1.2 m.) high. There is a rough retaining wall at the north end consisting of stacked large boulders with one upright. At the south side of the entrance is a 6' (1.8 m.) N/S by 7' (2.1 m.) E/W roughly paved area which drops off 4' (1.2 m.) into the cave. The cave interior has a small soil terrace area with plentiful midden at the south end. Here, a fragment of a human femur and cranium lay on the surface. Farther in the interior of the cave are loosely piled boulders -- another possible burial. The interior of the cave measures 17' (5.2 m.) E/W, 17' (5.2 m.) N/S with a maximum ceiling height of 5' (1.5 m.). Coral was also observed on the soil surface. This is a pre-historic temporary habitation and burial cave and is relatively undisturbed with intact deposits. In the sink area 6' (1.8 m.) to the west of the entrance is a rough paved area measuring 6' (1.8 m.) square. No artifacts or midden were observed in this area. The cattle wall which extends north from State Site 926 is 65' (19.8 m.) west of the cave entrance.

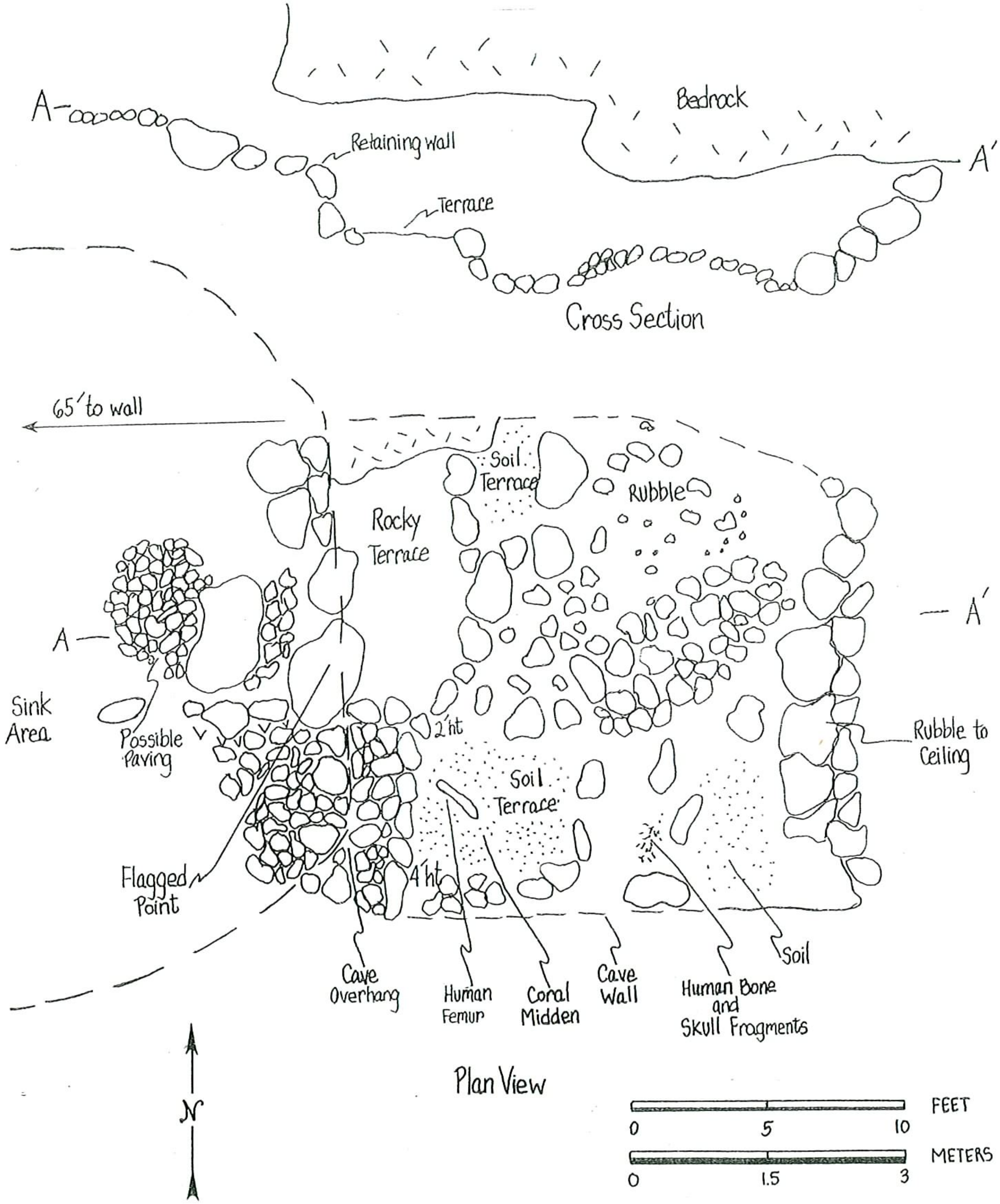

Fig. 25 State Site 939. Cave Plan View and Cross Section

State Site 940

Description (Fig. 26):

This site consists of a fairly level cobble-paved platform (Feature A) with a roughly triangular shape measuring 20' (6.1 m.) N/S by 28' (8.5 m.) E/W. The platform has no visible facing on the north, east and south sides which are leveled with the ground surface. The west side has a facing measuring 1.5' (.5 m.) high. Construction seems to be rough. This paved area could have been used for habitation or possibly a burial because of the formality of the paving. A coral cobble was observed on the ground at the south end of the feature. Otherwise, no midden or artifacts was observed. This site is in a low sink area surrounded by a low wall (Feature B) which encloses the sink area. This wall, a low piling for slope retention on all sides except at the west end, is free-standing to a height of 2' (.6 m.) and width of 3' (.9 m.). Feature C is an enclosure, a temporary shelter formed by a 3' (.9 m.) high, 3' (.9 m.) wide core-filled wall on the NW and W sides. The E and SE sides are formed by a rough retaining wall. This rough wall of piled boulders continues in both directions to form an enclosed area around State Site 940. No midden or artifacts were observed in the area. The low wall encloses an area 90' (27.4 m.) NE/SW and 60' (18.3 m.) NW/SE. Only at the west end is it freestanding. This site, including all 3 features, is a probable temporary prehistoric habitation and/or burial area.

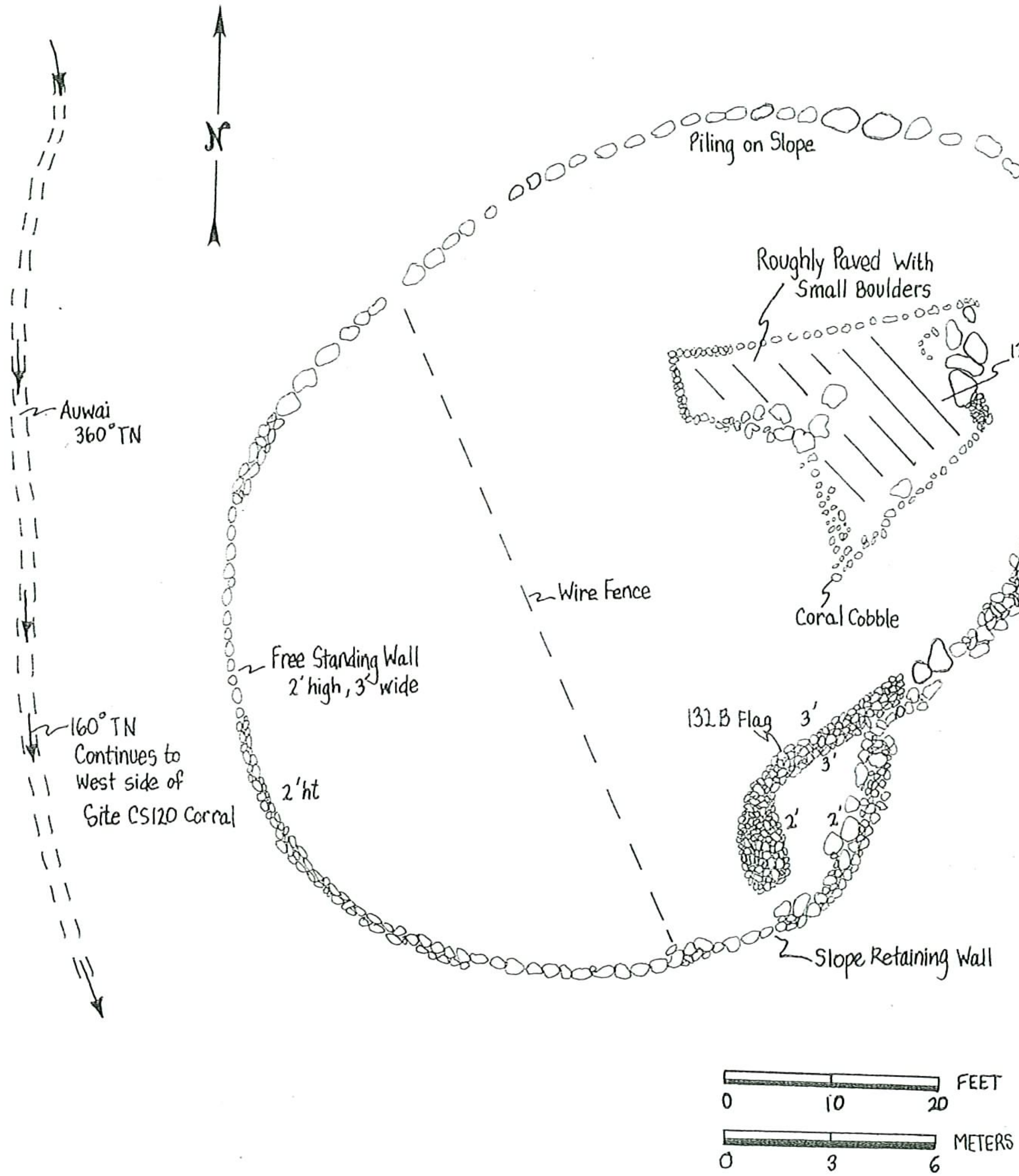

Fig. 26 State Site 940, Platform and Enclosure; Plan View

State Site 941

Description:

This is an _'auwai_ of pre-historic age which may have been used in historic times for sugar irrigation. The _'auwai_ is a depression 3-4' (.9 - 1.2 m.) wide and is defined on both sides by linear mounds of boulders and soil 2' (.6 m.) high and 3' (.9 m.) wide. The _'auwai_ is traceable from the bulldozed trail on the _makai_ side of the railroad berm and travels southward for a traceable distance of 320' (96 m.) passing along the eastern side of Platform Site 952. It then runs along the west side of Site 948 beyond which it is no loner traceable. The starting and ending points of this site are not determinable because of bull-dozing at both the _mauka_ and _makai_ terminal points. There are no fields visible along its edge that would have been irrigated by this _'auwai_.

State Site 942

Description (Fig. 27):

This site consists of a rectangular enclosure surrounded by a large walled field and is located at the western end of the project area near Hapa Road.

The habitation enclosure is an historic era house site. The house and the surrounding enclosing wall are correlated to LCA 3326 which according to the Native Testimony contains a house site and _lo'i_. The Land Court Award as shown in Monsarrat's map only roughly matches the enclosing wall. The habitation site

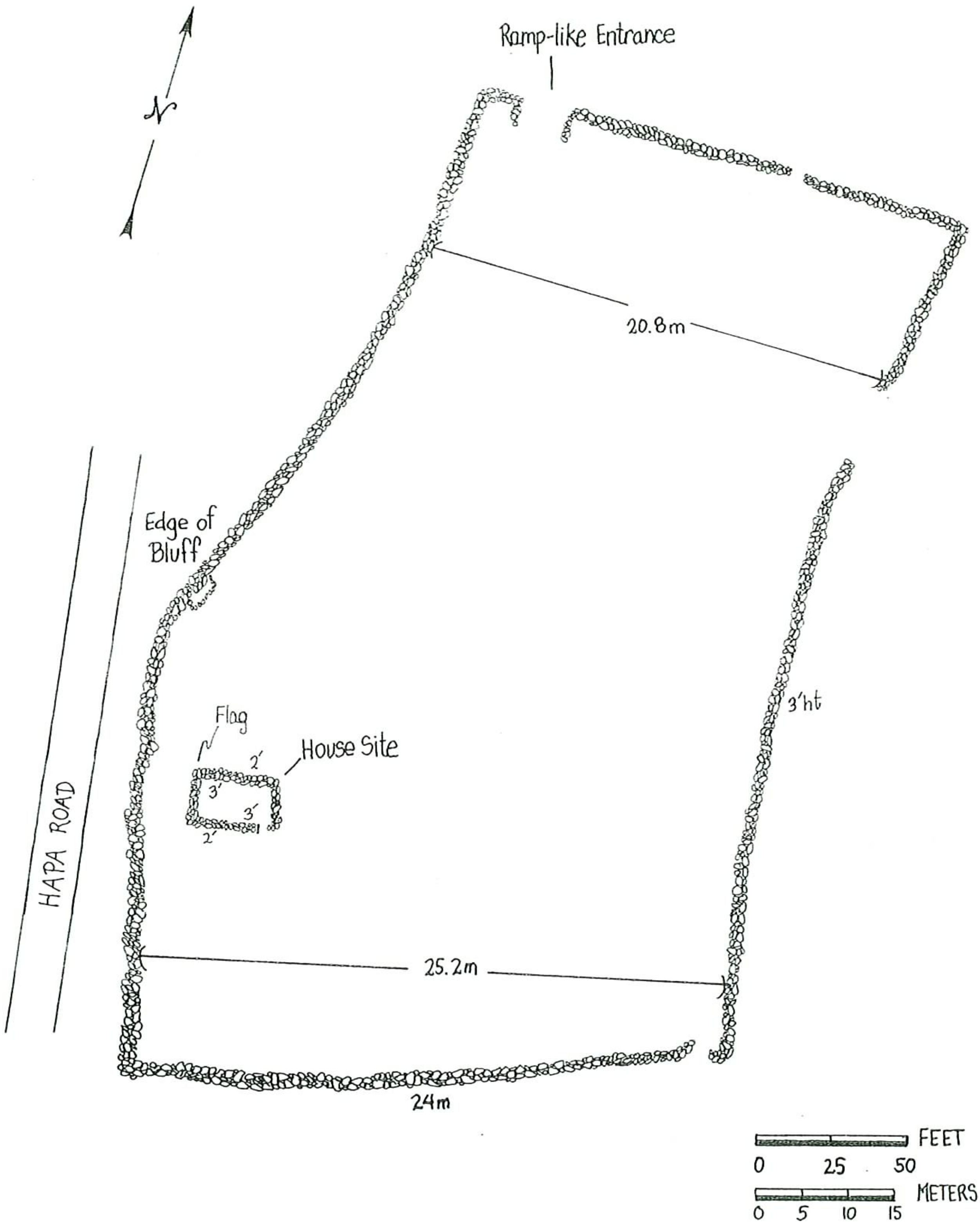

Fig. 27 State Site 942, Field Enclosure and House Site; Plan View

probably corresponds to the house lot award. Monsarrat's map (Fig. 5) shows 3 separate structures. At the westernmost of these is probably Site 942 habitation enclosure. Another LCA (3415) mentions lo'i to the northeast. No structures or surviving fields mark this LCA on the ground. Site 942 is a rectangular structure measuring about 25' (7.6 m.) E/W x 16' (4.9 m.) N/S. It has a 2' (.6 m.) break in the walls forming the entrance at the SE corner. The walls average 3' (.9 m.) high but on the northeastern side the walls have been collapsed and appear to have been bulldozed. The interior floor of the house site is 1' (.3 m.) higher than the outside. There are no visible cultural contents within the interior; however, approximately 200' (61 m.) to the east is a surface scatter of late 19th-Century/early 20th-Century bottles and ceramics. There is a long wall that runs along the western side of the house site and forms a large surrounding wall enclosing an area 200' (61 m.) E/W by 300' (91.4 m.) N/S. This is a probable field wall standing 3-4' (.9-1.2 m.) high, 3' (.9 m.) wide and is of stacked boulders and has openings at the N, NE and SE ends. The correlation of this site to an LCA shows strong evidence for an historic age.

State Site 943

Description (Fig. 28):

This site consists of an 120' (36 m.) long section of 'auwai oriented 350° TN. The 'auwai consists of 2 parallel mounds of soil from top to top 8' (2.4 m.) apart. The interior of the

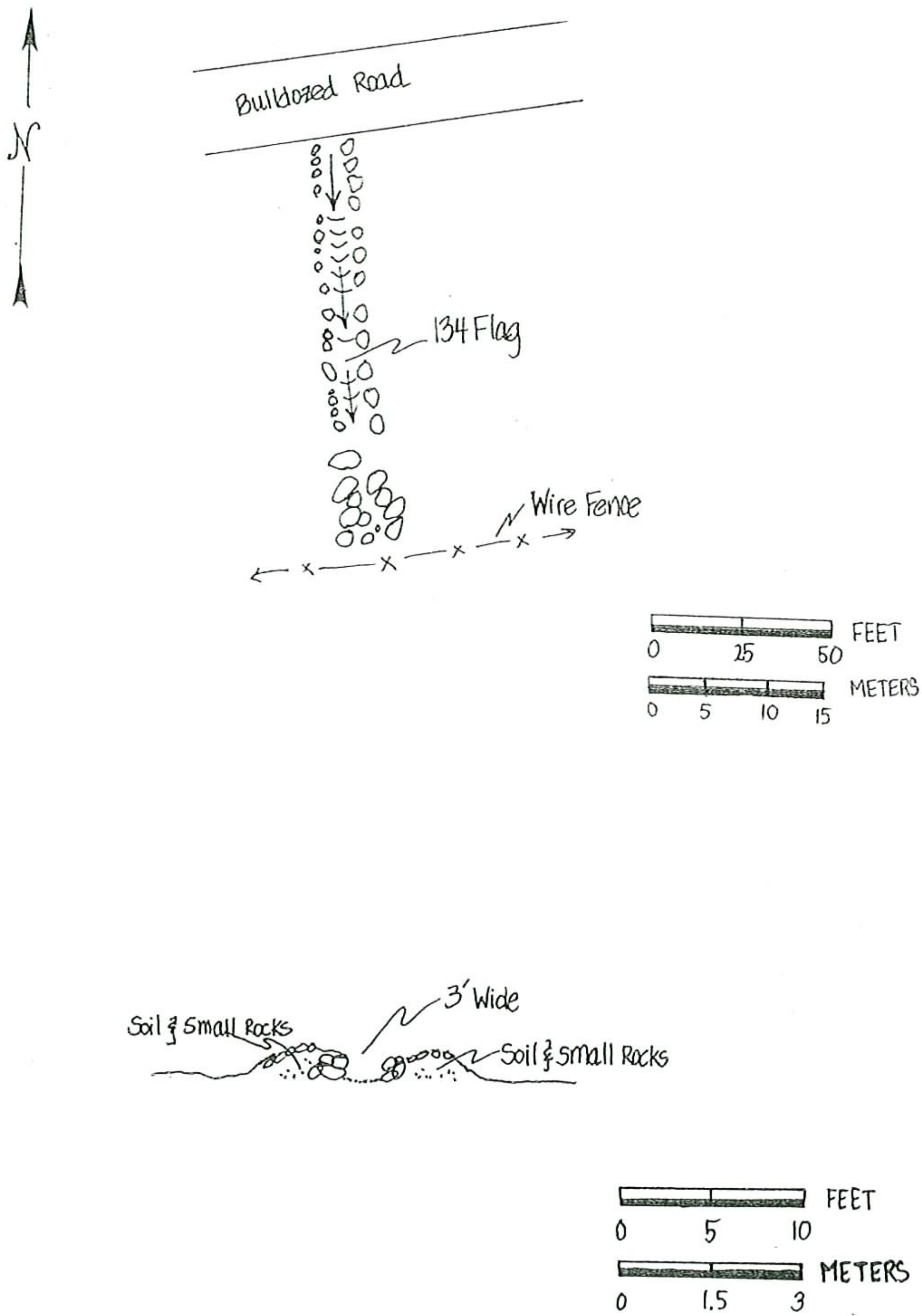

Fig. 28 State Site 943, 'Auwai; Plan View and Cross Section

mounds are at places lined with parallel alignments of small boulders 3-3.5' (.9-1.1 m.) apart. The _'auwai_ connects to the west side of Site 945 _'auwai_ running 200' (61 m.) _mauka_ discontinuously to a bluff. At this locality the _makai_ end is destroyed by bulldozing. The _'auwai_ is in poor condition and heavily impacted by bulldozing for pasture improvements. The terminal points, 120' (36 m.) apart, are bulldozed so the origin and end points cannot be determined. This is a pre-historic site which may have had historic use for sugar cultivation.

State Site 86 (Bennett Site 86)

Description (Fig. 29):

This site is a well-constructed permanent habitation platform. It is roughly rectangular in shape and measures approximately 25' x 45' (7.6-13.7 m.). The platform has walls which are core-filled, including some coral cobbles, and are well-faced, both on the interior and exterior sides. The maximum height of the walls is 1.5-2.5' (.8 m.-.8 m.) on the exterior side and 1-2' (.3-.6 m.) for the interior. The platform has two different sections. The eastern section is well-paved with a surface of small pebbles. The western portion is slightly lower and is roughly paved with a surface of boulders and cobbles. Extending off the middle of the south wall is a "_lanai_"-like feature, approximately 14' (4.3 m.) square. This extension has a rock-lined pit 4' x 6' (1.2 x 1.8 m.) by 1' (.3 m.) deep in the

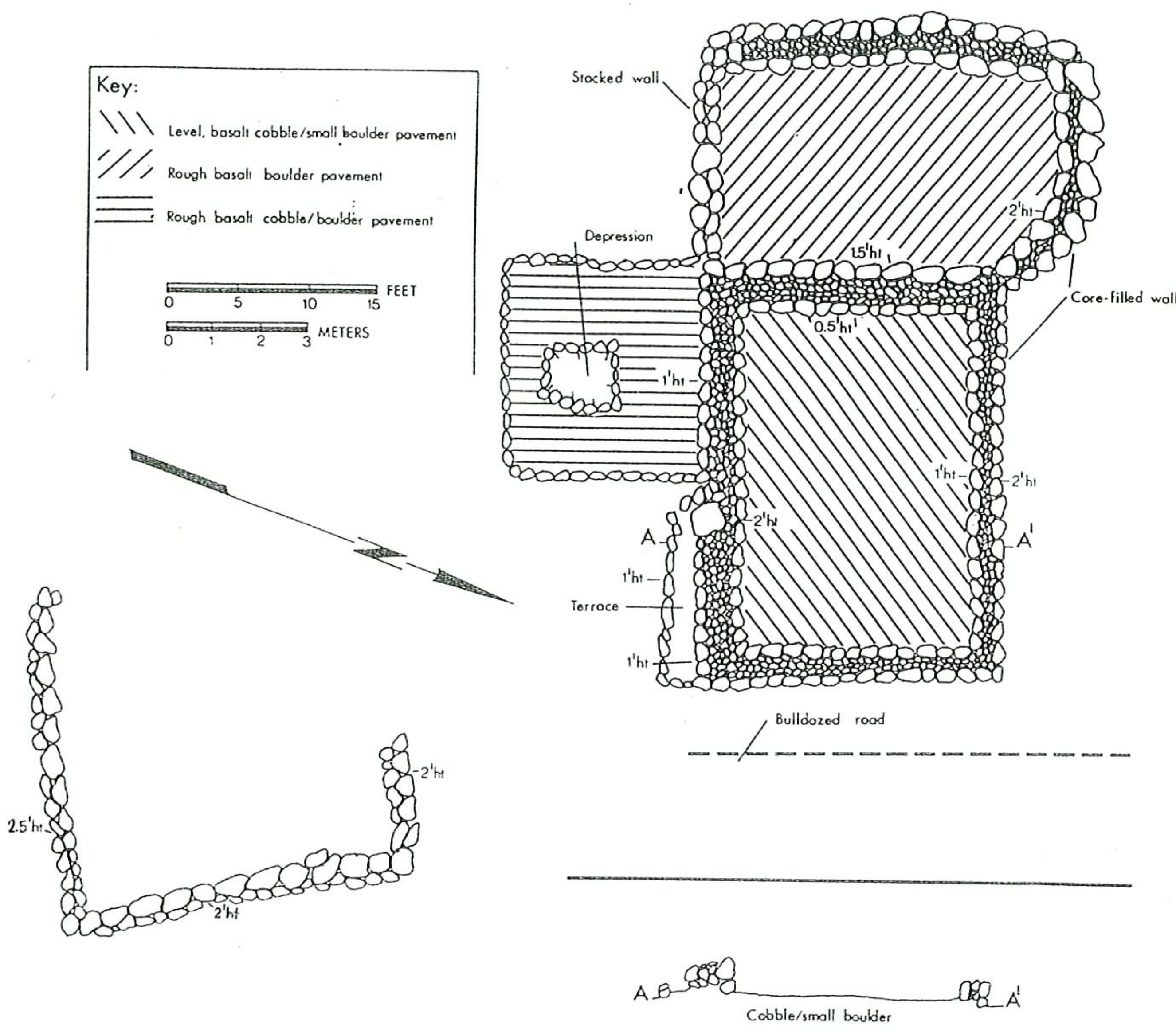

Fig. 29 State Site 86 (Bennett Site 86), Habitation Platform; Plan View and Cross Section

center. Also 24' (7.3 m.) to the southeast is a three-sided wall feature. The walls are of similar construction, core-filled, and are 2' (.6 m.) high. The south and east walls are 25' (7.6 m.) long with the north wall 10' (3 m.) long. This site is probably W.C. Bennett's site 50-30-10-86 (Bennett, 1931:120). It is recommended to be saved. No trace of historic debris was found here and the site is estimated to be pre-historic.

State Site 944

Description:

This is a pre-historic rocky agricultural area which is on the west side of a 5' (1.5 m.) high bedrock outcrop. The agricultural area measures 200' (60 m.) N/S by 100' (30 m.) E/W. The features include low mounds averaging 8' (2.4 m.) long and 1.5' (.45 m.) high and 3' (.9 m.) wide. These are between low bedrock outcrops with rock pilings on them. These are clearance mounds to consolidate rocks for the purpose of making small open soil areas for planting. No visible 'auwai is seen to enter this area, but generally similar areas in Kīahuna were irrigated from 'auwai. The water slowly trickled downslope between the mounds. No historic modifications of this system are evident.

State Site 945

Description (Fig. 30):

This site consists of a rectangular enclosing wall measuring 100' (30.5 m.) NW to SE and 80' (24.4 m.) NE to SW. In the E and

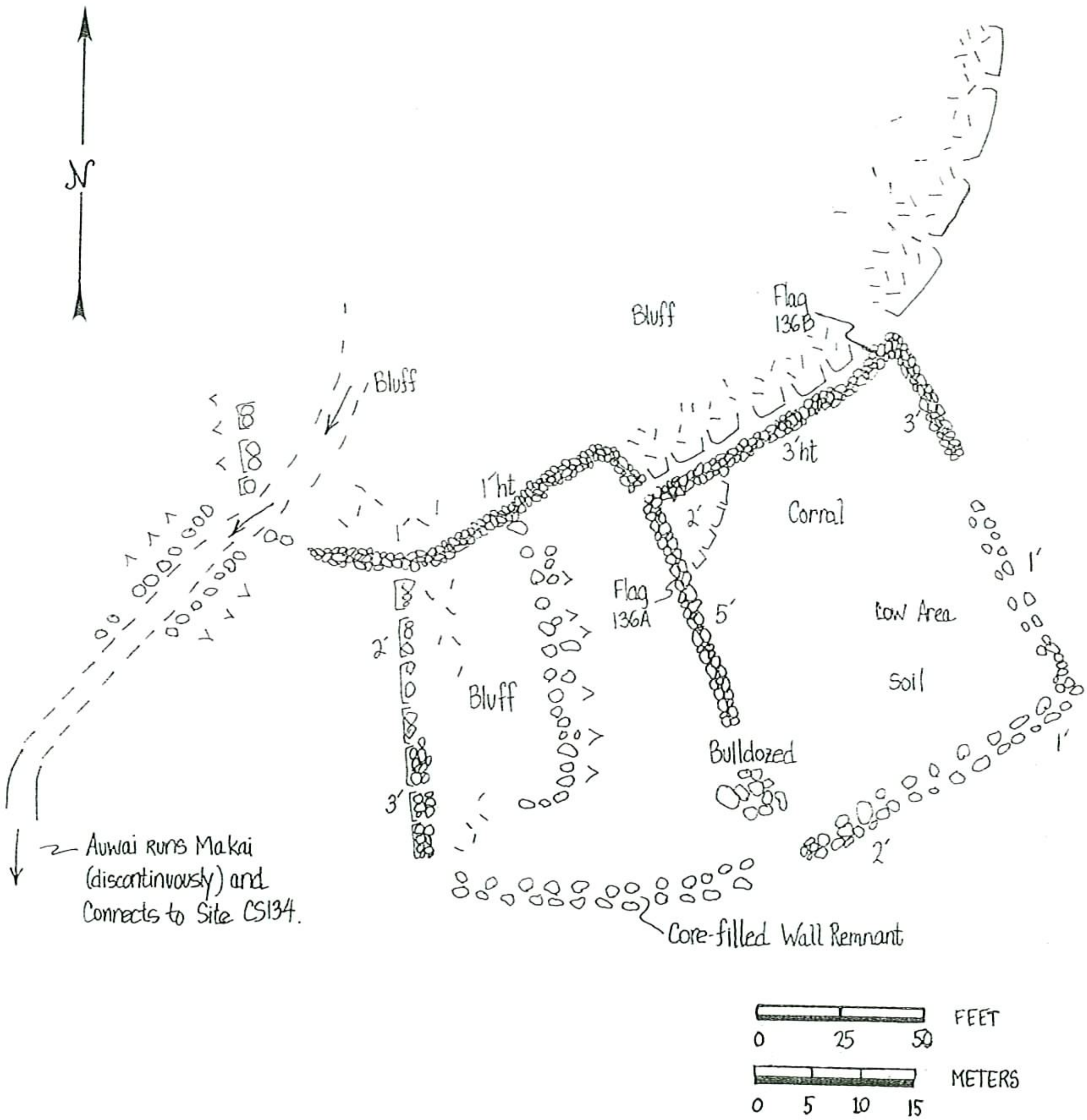

Fig. 30 State Site 945, Corral, Walls and _'Auwai_; Plan View

SE portions of the wall only the lower course of boulders remains and there are bulldozed gaps in the wall. The NW wall is fairly intact and is built along the edge of the bluff and reaches a maximum height of 3' (.9 m.). Construction of the wall consists of well stacked boulders on the outside with small boulders and cobbles which fill the rest of the wall. The wall averages 3' (.9 m.) wide. The SW wall of the enclosure is 3' (.9 m.) wide and reaches a maximum height of 5' (1.5 m.). At the exterior of the enclosure there were fragments of dark green bottle glass and ironstone ceramic. There are two bluff-retaining walls that run westward from this enclosure. They are less formal in construction and rocks have been robbed from them. The walls average 1' (.3 m.) wide and 1.5' (.5 m.) high.

This corral is considered to be an historic ranching area on the basis of wall construction with no evidence of pre-historic use.

To the west of the corral the bluff retaining walls may be remnants of prehistoric irrigated fields. A remnant of an _'auwai_ runs across the bluff at the NW end of the complex. This _'auwai_, consisting of parallel alignments of rocks 3' (.9 m.) apart, is barely traceable but is elevated off the bluff by an "aqueduct" feature consisting of an artificially raised mound with the _'auwai_ on top. This aqueduct is traceable for 40' (12.2 m.) onto bulldozed terrain but the _'auwai_ discontinuously connects to Site 943. This site includes a pre-historic field component but has been modified to include a cattle pen, so it is pre-historic with historic modification and use.

State Site 946

Description (Fig. 31):

This site is a lava tube which is penetrable from the south end for a distance of 420' (128 m.) <u>mauka/makai</u> (N/S). There are two separate entrances, with the main entrance at the south end at the beginning of the tube. This entrance is in the north side of a rocky sink area and measures 17' (5.2 m.) wide and 4' (1.2 m.) high. The entrance is partly blocked by boulder rubble and roof collapse.

The second entrance is 75' (22.9 m.) from the south end and consists of a collapsed ceiling hole on the east side of the tube measuring 4' (1.2 m.) in diameter. At the <u>mauka</u> terminus of the tube is a rubble pile which may have once been a third entrance.

The floor of the cave is mostly soil along the central length of the tube. Ceiling height varies from 3 to 6' (.9-1.8 m.). Cultural modification is confined to the length of the tube between the 2 <u>makai</u> entrances and within 50' (15.2 m.) of the <u>mauka</u> end. These modifications consist of boulder alignments, rough paved areas and a wall, and are typical habitation features for sleeping areas, work areas, etc. Each of these features is described separately below.

Feature A is a rough paved area measuring 10' (3 m.) E/W by 7' (2.1 m.) N/S; on the north side of the paving is a 2' (.6 m.)

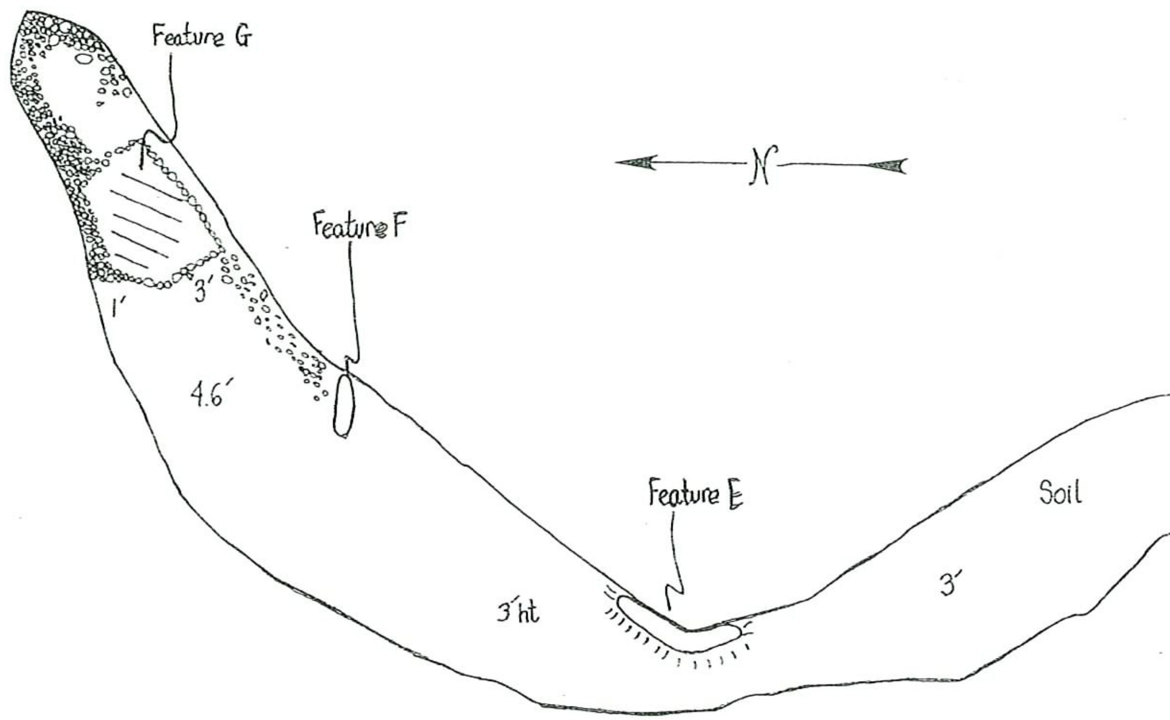

Fig. 31 State Site 946, Lava Tube; Plan View

high facing consisting of piled boulders. Adjoining to the south is a 8' (2.4 m.) in diameter soil mound standing 1.5' (.5 m.) high. To the north are two linear scatters of loose boulders. The open space in the center may be a cleared path. The paved area and facing probably represent prehistoric Hawaiian use of the cave for habitation. A few marine shells were observed scattered on the surface. The dirt mound is probably a modern modification of unknown purpose. Feature B consists of 2 wall sections on the east and west sides of the tube. The west wall is 10' (3 m.) long, 3' (.9 m.) wide and a maximum of 2' (.6 m.) high. The east wall is 7' (2.1 m.) long, 3' (.9 m.) wide and 2' (.6 m.) high. This is a probable prehistoric feature which may have been an attempt to block access to a portion of the cave.

Feature C is a rubble pile measuring 15' (4.6 m.) in diameter with a rough 2' (.6 m.) high facing on the west side. Most of this feature is associated with collapse around the ceiling hole entrance but there is some modification.

Feature D is a paved area 1.5' (.5 m.) high measuring 15' (4.6 m.) NW/SE and 7' (2.1 m.) NE/SW. This is a probable prehistoric feature, possibly representing a partition (for sleeping?).

Feature E is a hand-dug linear trench 2' (.6 m.) deep, 3' (.9 m.) wide and 18' (5.5 m.) long. The trench was excavated into the soil deposit along the east wall of the tube and the soil was piled on the west side of the trench. This feature is thought to be of historic age and may be an attempt to pool water for watering cattle. To the south, 80' (24.4 m.) from this feature is the skeleton of a cow. This and other scattered cow bones indicate that cattle had access to this cave and may have used it as a watering place.

Feature F is another hand-dug trench measuring 10' (3 m.) E/W, 3' (.9 m.) wide and 2' (.6 m.) deep. This trench in a low place on the cave floor is probably another historic ranching modification.

Feature G is a rough boulder platform measuring 22' (6.7 m.) NE/SW by 18' (5.5 m.) NW/SE. The platform is faced on the NE, SE and SW sides with facings of from 1' (.3 m.) to 2.5' (.8 m.). The top of the platform is uneven, consisting of piled boulders. A piece of coral was observed at the SE end of the platform. This feature is interpreted as a probable burial feature. If burials are interred here they would have been placed in the soil deposit underlying the boulder paving.

Generally, given the size of the tube, evidence of traditional Hawaiian modification is not extensive except for the entrance areas. No refuge use is indicated. The probable prehistoric features are confined to the _makai_ end and _mauka_ end with the areas in between consisting of a soil floor with no evidence of occupation such as shell midden or charcoal. The soil deposits in and around Features A-D and G have potential for containing extensive buried cultural deposits of permanent habitation and Feature G is a probable burial. The cave is an intact, pre-historic site with minor modern disturbance of soil deposits.

State Site 947

Description:

The east branch of the Kōloa Landing sugar train railroad berm traverses the project area for a distance of 1,650' (503 m.) from SW to NE in the makai section of the parcel. The berm is constructed of stacked boulders with facing on both sides and a fill of smaller rocks and soil. At the southwest end the berm reaches the greatest height of 6' (1.8 m.) and is consistently 10' (3 m.) wide. At the far southwest end is a constructed inset for an 'auwai water flow under the berm. As the berm traverses NE it gets progressively lower and there is collapse of the facings in some sections. At the NE end the berm is nearly level with the ground surface, maintaining a height of 3' (.9 m.) or less. At one time this railroad was used to haul cane from Weliweli and Pa'a to Kōloa Landing. A preserved section of the berm is visible on the west side of the Kīahuna Golf Course entry road. The berm does not appear on the 1891 Monsarrat map (Fig. 5) but does appear on the 1911 Kōloa Sugar Co. Map (Fig. 6A) so it almost certainly dates to within a few years of 1900.

State Site 948

This site is a large wall-enclosed field system in a relatively rock free low-lying soil area. The enclosing wall surrounds an oval shaped area approximately 210' (64 m.) E/W by 420' (128 m.) N/S. The wall is a typical cattle wall measuring 5' (1.5 m.) high and is 3' (.9 m.) wide at the base. It is too high to be a field wall and is free-standing. There are 6 interior walls mostly running _mauka/makai_ which are 1-2' high mounded terrace walls defining the field plots which average 10' (3 m.) wide and 30-60' (9-18 m.) long. In the center of the enclosed area is an _'auwai_ section running NW to SE and traceable for 120' (36.6 m.). A portion of this _'auwai_ is raised above the surrounding terrain 2' (.6 m.). There are various internal enclosures which are described separately below. This site is a pre-historic field area with historic modifications which include the addition of a cattle wall surrounding it.

State Site 949

Description (Fig. 32):

Site 949 appears to be a temporary habitation site. The NW and SE corners are disturbed, partially damaged, and the walls are partially disassembled. Built on a eastward slope approx. 25' (7.6 m.) E of the W perimeter wall of Site 948.

The enclosure measures internally 10' (3 m.) N/S by 8' (2.4 m.) E/W with walls 4-5' (1.2-1.5 m.) high and 2-3' (.6-.9 m.) wide. The interior is loose soil. The west wall abuts a terrace retaining wall. The site is in good preservation. No midden or artifacts were observed. This site is independent of the surrounding cattle wall and is judged to be a part of the pre-historic field plots.

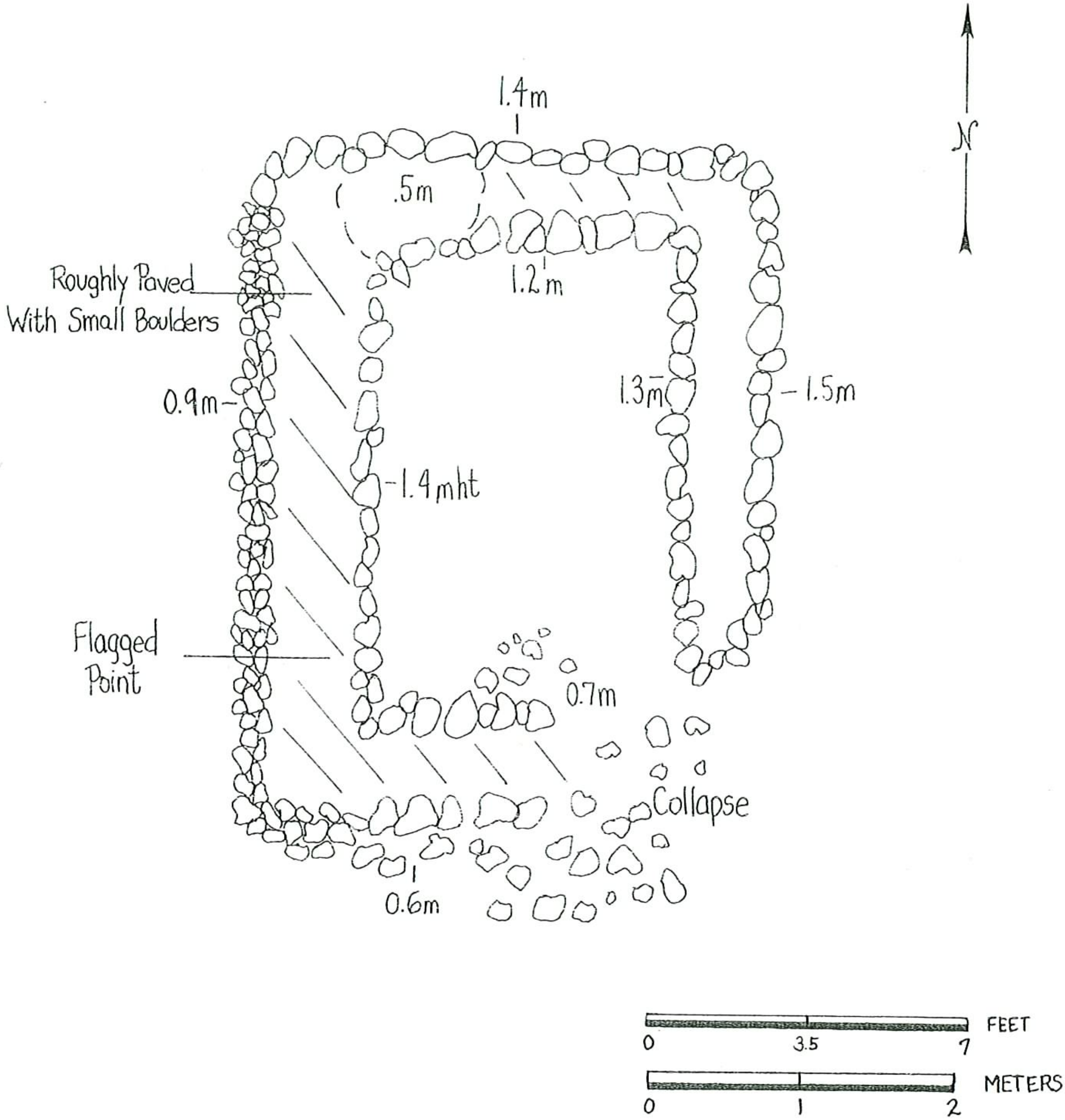

Fig. 32 State Site 949, Enclosure; Plan View

State Site 950

Description:

This site is 15′ (4.6 m.) by 35′ or 10.7 m. (internal dimensions); with walls 3 to 5′ (.9-1.5 m.) high, 3′ (.9 m.) wide of well-faced stacked boulders; pebble and cobble paved interior, the boulder curbing in the northeast corner forms a rectangular 2′ by 3′ (.6 by .9 m.) feature; the east wall abuts enclosing wall of site 948; and the feature is in a good state of preservation. No artifacts or midden were observed. The entire interior of the structure is filled with sisal plants and the floor of it is raised 1-2′ (.3-.6 m.) above the exterior ground level. It is a probable animal pen and is judged to be of historic age because it is connected to the historic cattle wall surrounding the site (948). It is not considered a habitation site because no internal features appear to be present and because there is no occupation debris visible.

State Site 951

Description:

This is a temporary habitation enclosure with the south wall built against the southwest side of the enclosing wall of Site 948. The interior of the enclosure measures 10′ (3 m.) by 15′ (4.6 m.); the walls are 3′ (.9 m.) high, and 2′ (.6 m.) wide and of stacked boulders. It has a rocky floor, shows signs of some disturbance and shows no midden or artifacts. Because it incorporates the cattle wall (Site 948) it is judged to be historic in age.

State Site 952

Description:

This site is a permanent habitation platform located west of Site 948 and along the edge of an NW to SE oriented <u>'auwai</u> section. The platform is 40' (12.2 m.) long NW/SE and 20' (6.1 m.) wide NE/SW. The platform is roughly paved with loose boulders and cobbles and stands 2-4'(.6-1.2m.) above the surrounding terrain. There is rough facing on the NW, SW and SE sides. Near the center of the platform is a collapsed slab-lined cupboard 3' (.9 m.) long, 2' (.6 m.) wide and 1.5' (.5 m.) deep. No midden or artifacts were observed. This is judged to be a pre-historic permanent habitation based on size and formality of construction.

State Site 953

Description (Fig. 33):

This site consists of a 2-level platform. The upper level has boulder facings on all 4 sides and is 4' (1.2 m.) high. N/S the platform measures 12' (3.7 m.) and E/W measures 15' (4.6 m.). There is a depression on the surface about 2' (.6 m.) in diameter and on the E and S sides is a 2' (.6 m.) wide lower level bordering the platform center. The SW corner is collapsed. This monumental platform is faced with 1-2' (.3-.6 m.) square slab boulders placed upright. At the S edge of the platform is a bedrock outcropping in a terrace formation, semicircular, approx. 5-6' (1.5-1.8 m.)

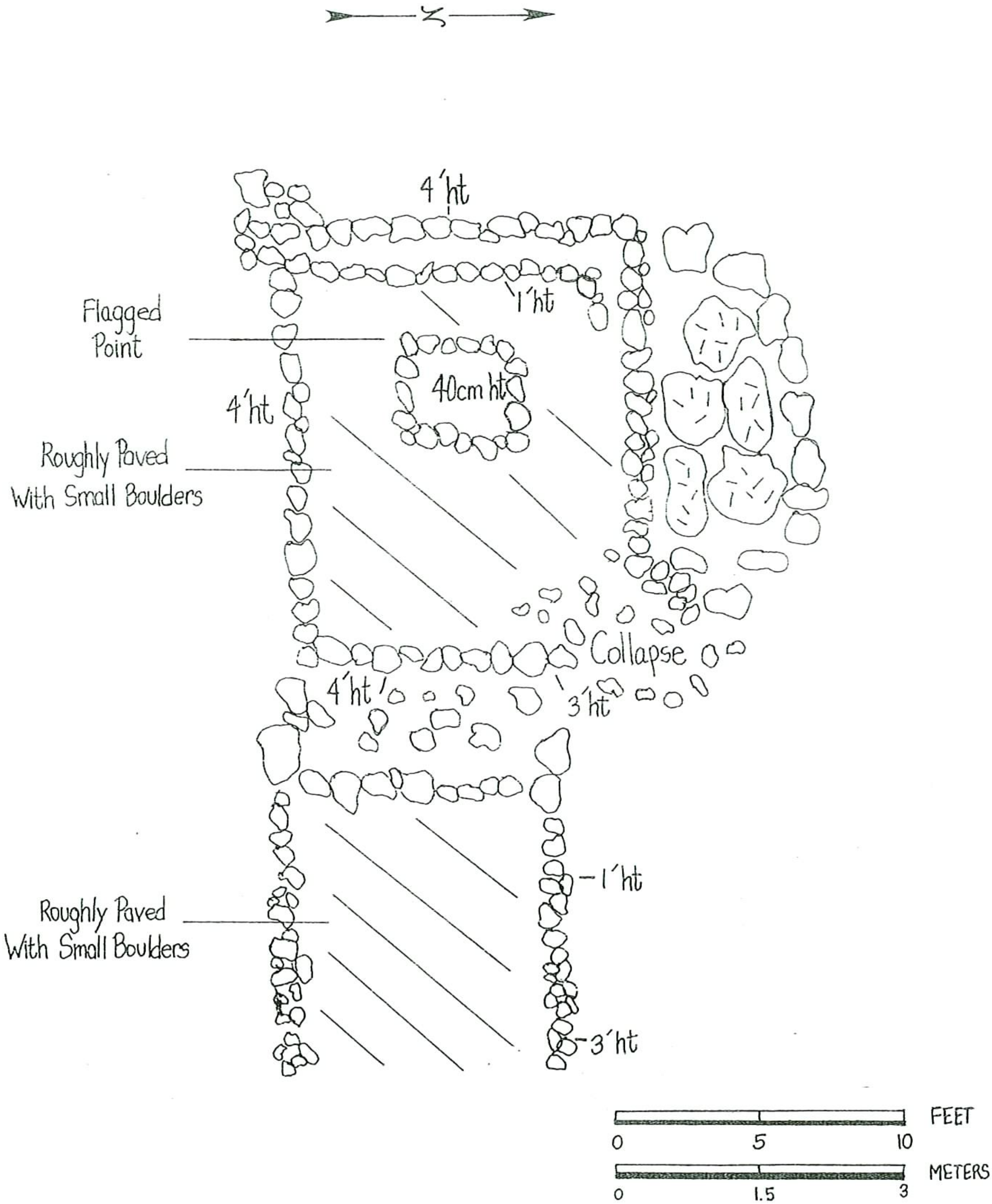

Fig. 33 State Site 953, Probable Burial Platform Plan View

maximum distance from the S side of the platform. No midden or artifacts were observed on the surface of the high platform.

A lower platform, which is attached to the high platform on the west side, is 12' (3.7 m.) square and is 1.5' (.5 m.) high at the SW corner. At the west boundary of the lower platform is a bulldozed tailing of a waterline and approximately 40' (12.2 m.) farther west is the railroad berm. No artifacts or midden were observed on the lower platform. S of the Monumental Platform is an area of boulders, delineated on the W side by a wall running N/S and some irregular soil terraces, with a maximum size 6' (1.8 m.) square. The high platform is considered a probable burial site. It is high and formally faced and unpaved. Both the high platform and the low one are judged to be pre-historic. The low platform is evaluated as a permanent habitation site.

State Site 954

Description:

This is a temporary habitation enclosure with external dimensions of 20' (6.1 m.) and a roughly oval shape. The walls are 3-5' (.9-1.5 m.) high and 4-5' (1.2-1.5 m.) wide of stacked boulders. The center of the enclosure contains a 2' (.6 m.) deep depression. An 'auwai branch section abuts the structure on the southwest and southeast sides. No artifacts or midden were observed. The structure is partly disturbed by surrounding bulldozing and is judged to be pre-historic in age.

State Site 955

Description:

This is a pre-historic agricultural mound located 50' (15.2 m.) to the east of Site 954. The mound measures 8' (2.4 m.) in diameter and has a maximum height of 2' (.6 m.). There are clearly defined facings along the edges. No midden or artifacts were observed.

State Site 956

Description:

This is a pre-historic C-shaped temporary habitation shelter measuring 10' (3 m.) E/W by 8' (2.4 m.) N/S. There are walls 3-5' (.9-1.5 m.) high, 4' (1.2 m.) wide of stacked boulders. The structure is horseshoe-shaped with pebble-paved floor. A cupboard 1.5' (.5 m.) in diameter with capstones missing is built into the north wall at floor level. There is a natural level area, 15' (4.6 m.) by 12' (3.7 m.), possibly paved, and located to the southwest with a large upright at the west end of the level area. No midden or artifacts were observed.

State Site 957

Description:

This is a pre-historic C-shaped, temporary habitation structure 7' (2.1 m.) in diameter open to the southwest. The back wall is 4' (1.2 m.) high, 4' (1.2 m.) wide and built of stacked boulders. There is a paved platform 6' (1.8 m.) square with a collapsed storage pit, 3' (.9 m.) by 2' (.6 m.) by 3' (.9 m.)

deep, attached to the southwest. No midden or artifacts were observed.

State Site 958

Description:

This is a pre-historic habitation enclosure for temporary habitation, 6' (1.8 m.) N/S by 8' (2.4 m.) E/W, built of stacked boulders with walls 3' (.9 m.) high and 4' wide. A 1.5' (.5 m.) high wall extends northwestward from the west corner of this structure for 20' (6.1 m.). No midden or artifacts were observed.

State Site 959

Description:

This is a pre-historic C-shaped, temporary habitation shelter open to the southeast. The structure exterior is 10' (3 m.) in diameter, with a back wall 3' (.9 m.) high and 4' (1.2 m.) wide. There is a rocky floor and a cupboard 3' (.9 m.) in diameter is built into the southeast wall. The cupboard is lined with uprights with a capstone cover in place. The site is in a good state of preservation. No midden or artifacts are present on the surface.

State Site 960

Description:

This site consists of two adjoining oval-shaped structures open to the west and located in an area of agricultural mounds and small cleared areas. The structures both of which are pre-historic, temporary habitation features measure 10′ (3 m.) long by 6-8′ (1.8-2.4 m.) wide with walls 3′ (.9 m.) high. Upright slabs form the interior facing on the east side. A low wall 1.5′ (.5 m.) high and 3′ (.9 m.) wide runs to the south and west for 60′ (18.3 m.) and connects to Site 961. No midden or artifacts were observed.

State Site 961

Description:

This is a poorly preserved remnant of a pre-historic, C-shaped, temporary habitation shelter open to the west and measuring 10′ (3 m.) N/S by 6′ (1.8 m.) E/W. Built into the wall is a 2′ (.6 m.) by 4′ (1.2 m.) cupboard 1.5′ (.5 m.) deep. The structure is partly collapsed. No midden or artifacts were observed.

State Site 962

Description:

This is a pre-historic, rectangular, temporary habitation enclosure measuring 10′ (3 m.) NW/SE by 8′ (2.4 m.) NE/SW. The walls are 1.5′ (.5 m.) high and 3′ (.9 m.) wide. The opening is to the southeast and the interior is rocky. There is no midden or artifacts on the surface.

State Site 963

Description:

This is a pre-historic agricultural enclosure defined by a circular wall 1.5' (.5 m.) high and forming a circle 45' (13.7 m.) in diameter. The interior of the enclosure is rocky and contains 2 low rock clearance mounds measuring 1.5' (.5 m.) high and 4' (1.2 m.) in diameter.

State Site 964

Description:

This is a pre-historic, C-shaped, temporary habitation shelter with interior dimensions of 6' (1.8 m.) by 5' (1.5 m.). The structure is open to the northeast and has walls 2' (.6 m.) high and 3' (.9 m.) wide.

State Site 965

This is a pre-historic, C-shaped, temporary habitation shelter with interior diameter of 6' (1.8 m.); it is open to the west. The walls are 2' (.6 m.) high and 3' (.9 m.) wide and are constructed of piled boulders. There is a 3' (.9 m.) square, 1.5' (.5 m.) deep cupboard with fallen capstones in the south wall. A low agricultural wall 3' (.9 m.) wide and 50' (15.2 m.) long curves to the south and west defining the planting area adjacent to the C-shape to the southwest. No midden or artifacts were observed.

State Site 966

Description:

This is an agricultural site enclosed by a cattle wall similar to Site 948. Only the northern portion of this large complex is within the project area. The enclosing wall is well constructed, measuring 5' (1.5 m.) high and 3' (.9 m.) wide at the base. In the interior are well-defined terraces bordering wet irrigated field plots. In the northeast corner is a 2-3' (.6-.9 m.) high, 20' (6.1 m.) wide, curved, core-filled wall which defines a lo'i. A well-preserved 'auwai enters the enclosure from the northwest and continues south through the entire site. This 'auwai is the main source of water for the entire site. It is defined by rocky parallel mounds with a 3' (.9 m.) wide channel in the center. A branch of this 'auwai feeds into the fields in the center of the enclosure. Another 'auwai - less well defined-enters the enclosure from the northeast but is not traceable northward. The main focus of habitation for this site is makai outside of the project area. This site encompasses pre-historic field walls in the interior but was modified in historic times with the addition of a surrounding cattle wall which encloses the fields. It is a pre-historic system with historic use.

State Site 967

Description:

This is a pre-historic, C-shaped, temporary habitation shelter within the Site 966 agricultural complex and measures 10' (3 m.)

N/S by 6' (1.8 m.) E/W. It is open to the southeast. The back wall is 4' (1.2 m.) high and 5' (1.5 m.) wide at the base. The interior is rocky with some collapse. No midden or artifacts were observed.

State Site 968

Description (Fig. 34-36):

Site 968 is a pre-historic, multiple feature, temporary habitation site consisting of two C-shaped shelter areas, one enclosure, and an adjoining wall. At the makai or southern end is the enclosure which is roughly circular in shape and 10' (3 m.) in diameter. It has a maximum wall height of 2.5' (.8 m.) and is constructed of stacked boulders. The interior of the enclosure is soil and loose boulders. Adjoining to the north are the two C-shapes, each measuring some 10' x 6' (3 x 1.8 m.) with maximum back wall heights of 3' (.9 m.). Extending northwest off the most northern C-shape is the wall which ranges in height from 1-3' (.3-.9 m.). The wall is broken down in some places due to bulldozing activities. Three test units were excavated in this site.

Excavation Results from Hammatt et al., 1985:

Test Unit 1, a one-square meter unit, was excavated in the enclosure. It revealed a maximum of 40 cm. soil overlying sterile subsoil (C-horizon). There was a total of 25 grams of midden recovered. Also collected were: one clear plastic fragment, one bottle glass fragment, and one volcanic glass flake.

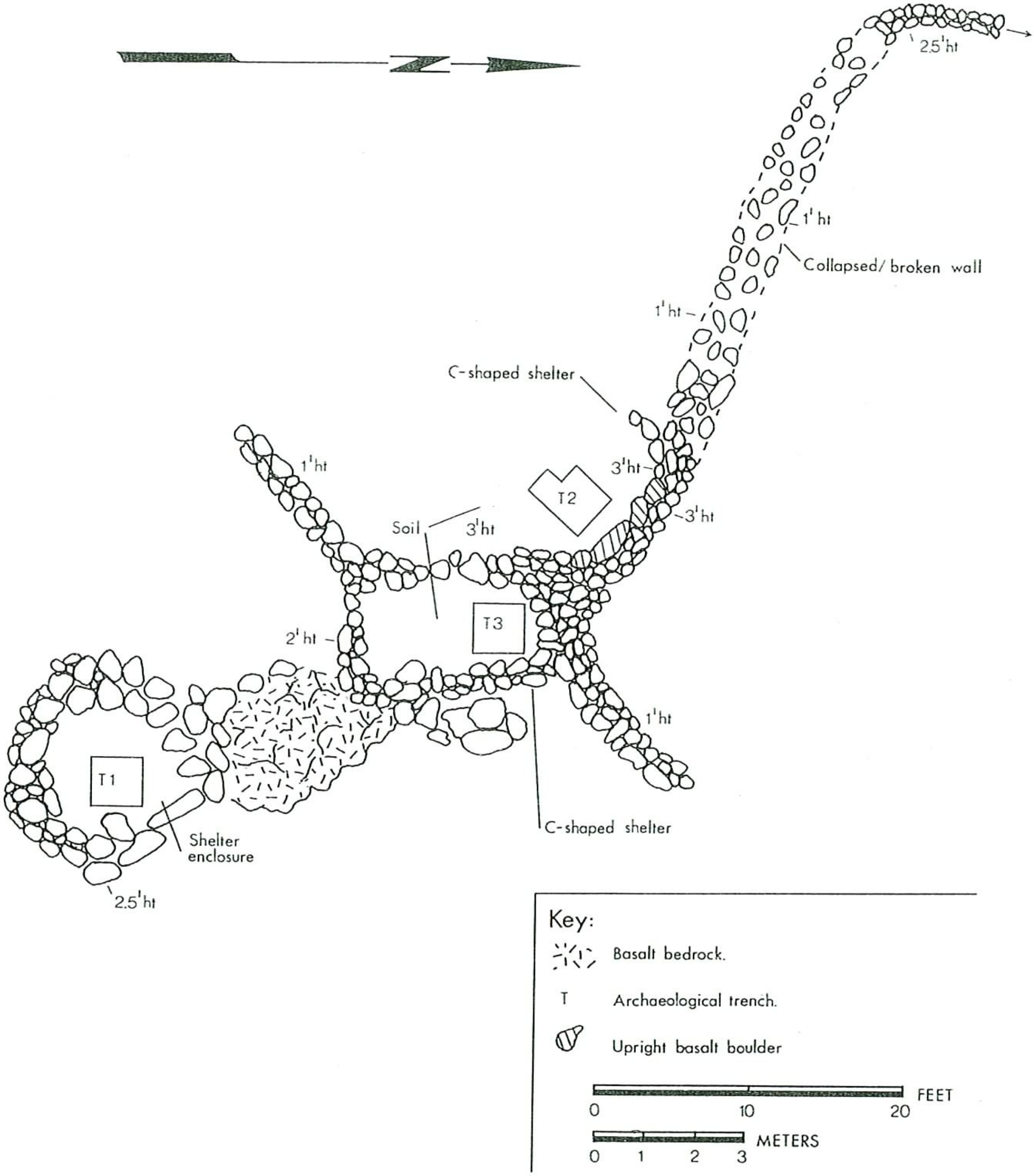

Fig. 34 State Site 968, Plan View Showing 1985 Test Trenches

Fig. 35 State Site 968, Trench 2 Pre-Excavation, View to North

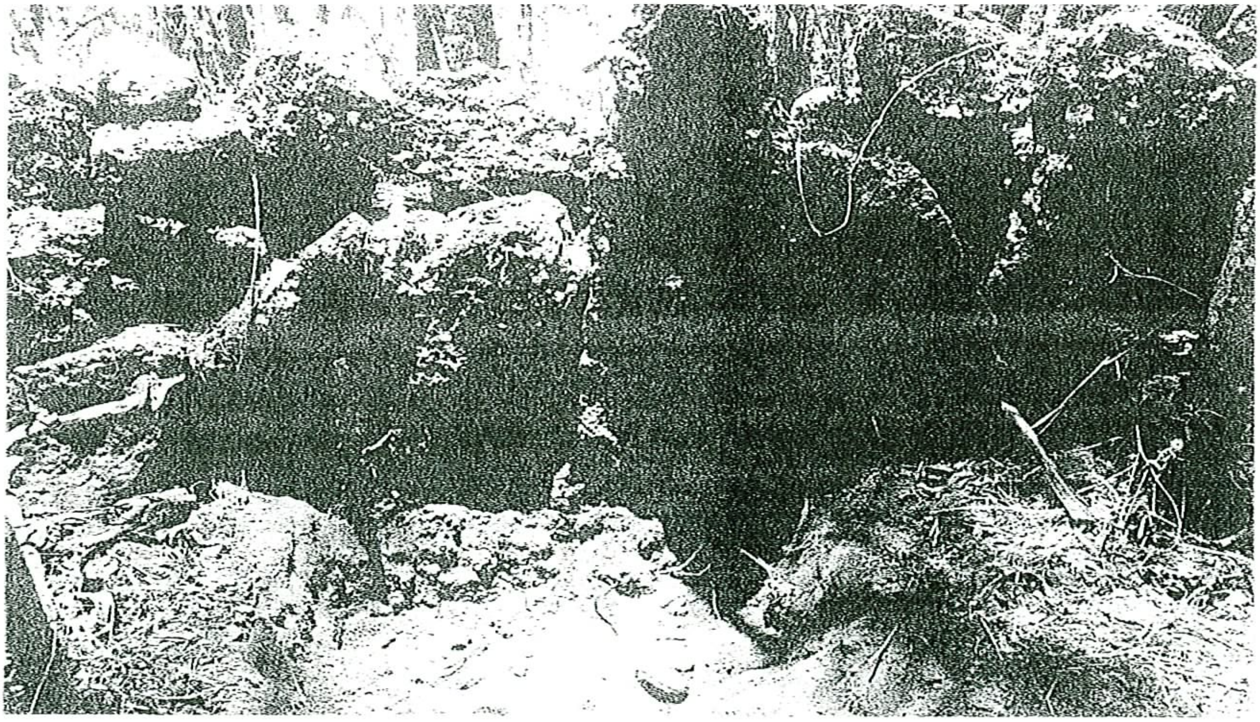

Fig. 36 State Site 968, Trench 2 Post-Excavation, View to North

Test Unit 2, a one-square meter unit, was excavated in the most northerly C-shape. It revealed a maximum of 35 cm. of soil overlying sterile subsoil (C-horizon). There was virtually no midden other than some charcoal (approximately 10 grams). However, a small hearth area was noted in the southeast quad of this unit and an additional 1.5' x 1.5' (.5 x .5 m.) area was excavated to collect a charcoal sample from the hearth area.

Test Unit 3, a one-square meter unit, was excavated in the C-shape between the enclosure and the northern C-shape. It revealed that most of the floor area of this C-shape was pahoehoe bedrock with soil only in bedrock cracks. There was no midden except for some charcoal flecking and no artifacts.

State Site 969

Description:

This is an 'auwai which runs to the east side of Site 908 and is defined as a 3' (.9 m.) wide depression with 3' (.9 m) wide and 1' (.3 m.) high rock mounds on either side. The 'auwai starts at a bulldozed area at the north end and runs south for 230' (69 m.). A possible branch of this auwai turns 90 degrees to the east where it may have joined Site 973 'auwai but the connection is unclear. The main branch terminates at this branch; further it is not traceable. This auwai is of pre-historic age and probably fed fields makai of the project area. It was probably used in historic times for sugar cultivation or may have drained fields mauka of it.

State Site 970

Description:

This is a rocky pre-historic agricultural area consisting of low mounds and rock pilings on small outcrops of bedrock. The site is similar to Site 944 in having linear mounds and amorphous rock pilings which were constructed to clear narrow meandering soil areas for planting. The site measures approximately 200' (60 m.) N/S and 400' (120 m.) E/W and is within a sloping terrain. No visible _'auwai_ entered this site area but former irrigation at the base of an _'auwai_ is likely. The area _mauka_ has been bulldozed and the area bordering the project boundary to _makai_ has been bulldozed. Mounds are generally 6 - 10' (1.8 -3 m.) high.

State Site 971

Description:

This is a short _auwai_ section which runs west of Site 954 and is traceable in a NW to SE direction for only 70' (21 m.). The _auwai_ is a 3' (.9 m.) wide depression, 1' (.3 m.) deep, and is bordered by low rock mounds on either side. The terminal points are both bulldozed and the _auwai_ is not traceable definitely into any field system. It may have fed Site 948 fields at the north end. It is of pre-historic construction with probable historic use for sugar. A branch of this _'auwai_ extends along the southeast side of Site 954 for 40' (12 m.) in a NE direction.

State Site 972

Description:

This is another short _'auwai_ section traceable for 100' (30 m.) in a N/S direction. It is entirely bulldozed at both ends. The depression is 4' (1.2 m.) wide, 1' (.3 m.) deep, with rough rock pilings on both sides. This is a pre-historic site which may have been used in historic times for sugar irrigation.

State Site 973

Description:

This is a well-preserved pre-historic _'auwai_ which is traceable for 400' (120 m.) in a N/S direction. It is defined by rocky parallel mounds with a 3'(.9 m.) channel in the center. This _'auwai_ enters Site 966, an enclosed agricultural site, from the north and runs along the west side of the site parallel to the west enclosing wall. A branch of this _'auwai_ runs downslope (east) to the north of Site 911 and feeds fields within Site 966. This _'auwai_ is well-preserved throughout its intact portion and extends _makai_ outside the project area for 650' (195 m.) to within 200' (60 m.) of Po'ipu Road. This is clearly a major _'auwai_ of the pre-historic field system and may have extended far through the center of the project area before bulldozing occurred. It is a definite pre-historic site and the _mauka_ end may have been used in historic times for sugar irrigation.

V. SUMMARY OF RESULTS

The project area, although it has been heavily modified for 19th Century sugar cultivation and long-term cattle grazing, shows the scattered remnants of a once-continuous wetland irrigated agricultural system.

This agricultural system, which is comparable to that in the Kīahuna land to the west, had its origins in late prehistoric Hawai'i and was probably in continuous use for hundreds of years before western contact. When Kōloa became a well-known shipping center for Kaua'i from the 1830s onward the agricultural system continued in use and was even intensified to supply foodstuffs for export. Eventually with the increasing demands for land and water for sugar production in the late 19th Century, the larger fields in level, less rocky areas were modified for cane cultivation. In many cases the traditional _'auwai_ continued in use to irrigate cane fields. Partly contemporaneous with the land alterations for sugar, the non-cultivated lands were modified for cattle grazing. A number of cattle walls and corrals were constructed and bulldozing occurred in level areas for ranch roads and to improve grazing.

In spite of this impact, 75 intact archaeological sites remain on the property. These are categorized and summarized as follows. Table 1 lists each site with significance assessments and correlates site numbers while Table 2 lists each site by functional categories and presumed age.

Permanent Habitation Sites

This category (8 sites in all) is distinguished from the temporary habitation sites on the basis of size (plan view dimensions and height) and formality of construction. Generally, these are platforms with paved surfaces measuring at least 60 - 100 sq meters. There is also an enclosure represented, Site 942, which is interpreted as an historic period house enclosure. Site 946, a lava tube, is included in this category on the basis of size of the interior chamber. The other cave in the project area (939) is listed as a temporary habitation site because it is smaller and has a confined inner chamber with a length of only 5 meters. The permanent habitation sites are generally isolated from each other except for a cluster of 3 on the makai side of the railroad berm. This clustering appears to be a function of selective preservation of this area from late 19th and 20th Century impact rather than a reflection of a pre-historic settlement pattern. All of the permanent habitation sites identified are estimated to be pre-historic in age except for Site 942 which is historic in age and associated with LCA 3326.

Temporary Habitation Sites

This site category is defined on the basis of size, construction formality, style and shape. The temporary habitation sites (31 in all) are smaller, with interior dimensions of around 10 sq. meters or less. The construction style is generally informal, with no paving, and there is minimal facing in the stone work. The predominant shape is a C-shape, with some small enclosures included in this category. The distribution of these sites is, again, largely determined by selective preservation. In undisturbed areas the shelter sites are scattered within the rocky agricultural areas. They were used as temporary shelter from tradewind showers during planting, maintenance and harvesting of crops. Some of these sites have associated storage cupboards, presumably for storage of agricultural produce or implements. Spatially, the greatest concentration of these sites occurs makai of the railroad berm on the east portion of the project area. Most typically, the shelter walls are highest on the northeast side to protect against prevailing windward rain. These sites are virtually all estimated to be pre-historic in age and are an integral part of the pre-historic field system in all areas where intact segments have been identified (Kīahuna, Kukuiula).

'Auwai(s)

There are 16 'auwai identified in the project area. These vary in construction from two parallel earthen mounds (for example, Site 938 'auwai) to rock-lined depressions with rock mounds on each side (Site 913 for example). Unfortunately, impact of land clearing for sugar cultivation and ranching has destroyed continuous lines of 'auwai and only short segments remain. Reconnecting these segments on paper to reconstruct the original 'auwai pattern is generally pure speculation. However, based on comparisons with the Kīahuna Project area where long sections of 'auwai are intact and by making connections between the more adjacent segments of _'auwai_ in the Po'ipulani project area, the following observations are presented.

1. The _'auwai_ pattern is generally dendritic with branching off proceeding from _mauka_ to _makai_.

2. Using the Kīahuna area for comparison it is apparent that there were main _'auwai_ which traversed continuously from _mauka_ to _makai_ which had secondary and tertiary branches on both sides which delivered water to all field systems an both sides of the main _'auwai_ and in the intact pre-historic system probably delivered water to all portions of the project area.

3. The only possibly clearly defined main _'auwai_ is _'Auwai_ Site 913 which can be traced _mauka_ from Site 913 (fields) for 700' (210 m.). This _'auwai_ could possibly connect to Site 930 _'auwai_ which may relate to the irrigation of fields in Site 926. On the west side of the project area Site 922 may represent another main _'auwai_.

4. All clusters of agricultural fields (913, 926, 945, 948, 966) show remnants of _'auwai_ which show that they were irrigated fields. Figure 4 shows which _'auwai_ fed which fields but because of the fragmented field evidence many of the connections are unclear. The path of the water through the fields was controlled by microtopography.

5. All of the _'auwai_ are estimated to be a part of the prehistoric irrigation system but some were used in the 19th and 20th Century for sugar cultivation apparently without modification. No mortared gates were found or any other sign of historic period modification. In the case of the _'auwai_ at Site 938, the

water channel was tunnelled through a sizeable cattle wall. This wall was probably constructed to exclude cattle from the sugar fields and the tunnel is a historic modification.

6. The intensity of pre-historic agricultural development is attested to in the existence of elevated _'auwai_, one example of which survives in the Po'ipulani project area. Other examples survive at Kīahuna and Kukuiula. Topographic irregularities were adjusted by human labor to allow water delivery over low points.

Agricultural Sites

These sites consist of clusters of adjacent fields which are defined by low field boundary walls, earthen mounds, and/or 5-6' high stacked boulder walls. These field plots vary in size from small terrace areas of 1-2 m. wide and 3-5 m. long to large rectangular fields, 10-12 m. on a side or larger. The low mounded walls and earthen mounds less than 50 cm. high are judged to be generally of pre-historic construction and reflect pre-historic (pre-cattle) agricultural activity (i.e. systematic field clearing and rock piling). The stacked boulder walls of 1-1.5 m. height are judged to be historic additions to the pre-historic plots specifically to exclude cattle. Well-preserved examples of pre-historic field clusters are Sites 913, 966 and 926. All except 913 have been modified to varying extent from their pre-historic configuration by the addition of cattle excluding walls. Sites 948 and 966 are totally surrounded by cattle excluding walls and 926 is identified as historic LCA 3601.

As for the spatial distribution of these sites, again by comparison to the Kīahuna project bordering to the west, they are considered to have once covered the entire project area with a continuous network of fields and terraces. They survive on the ground today only in rocky areas which were not impacted by sugar cultivation.

Burial Sites

There are relatively few sites within the project area which appear to have exclusive function as burial structures and generally burial sites do not figure prominently in the Kōloa fields. For example, no definite surface burial sites have as yet been identified within the Kīahuna and Kukuiula project areas. Site 953 is an exceptional site as it appears to be a monument platform constructed for interment of probably a high status individual. This structure is of a height impractical to be a habitation site. If height of the structure is a measurement of status of the individual(s) interred, then this may be a high status burial place. Other surface sites are mounds with internal features and may represent burial places. These include 919, 927, 928 and 936. Site 926 may contain a historic burial in a collapsed brick and mortar structure (Feature D). The previously mentioned cave sites (946, 939) almost certainly contain human burials. In all there are 8 potential burial sites.

In terms of what constitutes a site tentatively identified as a burial, a number of criteria apply. It is partly a process of elimination. For example, a site which is construed as a mound but which possesses a formality of design discouraging identification as an agricultural clearance mound and has no flat surface to serve as a living area is then classified as a burial site. In one case (Site 953) there is a level platform which is of a height which would make access difficult for a habitation platform. It is therefore classed as a burial. Site 939, the cave shelter, is a definite burial - a human long bone was identified in the floor deposits.

Historic Era Sites

Site 942, which consists of a rectangular house site and a large enclosing wall, is correlated to one of the 19th Century Land Court Awards and appears to be largely historic in age. Site 926, although it encompasses prehistoric field walls, appears to be largely historic in age with a corral and brick and mortar structure. Clearly, the most predominant historic structure is the railroad berm which crosses the project area in the makai section (Site 947). The berm is intact along almost the entire length and reaches its greatest height at the west end.

Settlement Patterns as Indicated by Survey Data

The following generalized patterns are presented for prehistoric, mid-19th Century, and the commercial sugar period:

Pre-historic Pattern

There is no evidence to indicate that the pre-historic use of the Po'ipulani project area was any less intense than that of the Kīahuna area bordering it to the west: i.e., complete use of the land for irrigated agriculture with dispersed, permanent habitation sites presumably for extended families laboring in segments of the fields. All of the fields were irrigated to one degree or another from lo'i to occasional water flooding in dry seasons. Dispersed in high areas within the fields are temporary habitation sites consisting of field shelters for small groups of people.

Mid-Nineteenth Century Pattern

The prehistoric system was essentially intact and was producing large supplies of export food goods for visiting ships in the mid-Nineteenth Century. The land and production was largely controlled by Governor Kaikio'ewa which explains the fact that there were only 3 Land Court Awards in the project area (all three containing agricultural land) which is assumed to have been heavily populated in a traditional settlement pattern until the expansion of commercial sugar in the latter part of the century. Throughout most of this period the traditional fields with low field boundaries remained intact without the addition of stacked boulder cattle walls. However, by the 1880s cattle walls were built to exclude grazing stock from enclaves of selectively used agricultural fields (942, 945, 948, 966). Those field sites without these protective walls are assumed to have been abandoned by a combination of failing supply of irrigation water, lower market value for victuals, and encroaching land uses such as commercial cane and cattle grazing.

Sugar Plantations and CAttle Ranching

Some time in the late Nineteenth or early Twentieth Century commercial sugar planting of the Kōloa Sugar Co. took over nearly the entire makai portion of the project area. It was at this time that the structural integrity of the pre-historic - early post-contact human landscape was dramatically altered, leaving only disconnected remnants in uncultivated areas which were too rocky to clear for commercial planting. Not all of this process was destruction. The railroad berm was built during this period. Some stacked boulder walls were built to enclose fields from cattle. Examples are the wall at the north end of Site 926 and Site 938 wall, both of which were probably constructed as cane field boundary walls. Many of the 'auwai constructed as part of the traditional pre-historic system were adopted for use for sugar irrigation without modification.

The final impact to what survived of this field system was brought about by the most recent use as cattle pasture. The 'auwai were abandoned and large tracts were bulldozed and rock clearing was systematic as a part of pasture improvement. A few walls were built for cattle control; for example, a large field (926A) was enclosed for a cattle pen. An extensive complex of cattle walls for paddocking is not apparent. The paddocking was done through wire fences this century. Many of the posts for these fences are railroad ties reclaimed from the railroad berm which runs southwest to northeast across the makai portion of the project area.

Comparison to the Ahupua'a Pattern

The phases of settlement evidenced within the Po'ipulani project are generally characteristic of the ahupua'a as a whole with some variation. For example, in other areas (Kīahuna), the pre-historic human landscape survives more intact because it was not used for commercial sugar except on the narrow floodplain of Waikomo Stream. In this way, Po'ipulani is more comparable to the Kukuiula project area in showing remnant survival of the ancient field system which is essentially uncultivated islands in commercial cane operations. In areas of thick soil deposits preferred for sugar lands towards Kōloa Town and west of Waikomo Stream, virtually no trace of the pre-historic fields survives. It appears that the general pattern of land use and the history of change is similar in all three project areas (which together encompass virtually all the surviving archaeological inventory for the ahupua'a). One cannot argue for greater or less intensity of pre-historic use except possibly for a differential in initial development. Allowing for wide variation in preservation of sites, one can project an ahupua'a-wide settlement pattern of intensive irrigated agriculture with dispersed settlement for all the makai lands and for the entire makai portion of Kōloa.

Significance

In spite of extensive historical and modern land modifications for cane cultivation and pasture improvement, a large number of significant archaeological sites still remains in the uncultivated portion of the project area. These sites are evaluated for significance according to the broad criteria established for the National and State Registers (see Table 1). The seven criteria are listed and briefly applied to the archaeological sites in the project area as follows:

A. Site reflects major trends or events in the history of the state or nation.

-There are certainly major economic trends reflected in the sites: namely prehistoric adaptations in the Kona District of Kaua'i and the transformation from a subsistence based traditional agriculture to a commercial plantation economy. This criterion seems relevant to the entire project area, but does not apply to specific sites.

B. Site is associated with the lives of persons significant in our past.

This would apply in cases in which there is a possibility of associating a feature to specific important individuals. There are no sites in the project area which fall into this category.

C. Site is an excellent example of a site type.

This criterion addresses quality of construction and design, as well as state of preservation. Sites which, in the judgment of the authors, are illustrative of an interpretive quality are included. These sites may not be the only one of their kind in the <u>ahupua'a</u> or may not be the best examples in the <u>ahupua'a</u> but they are the best examples in this particular project area.

Some of the habitation and agricultural sites, as well as agricultural sites, fit into this category. There are 10 sites in all which fit into this category.

D. Site may be likely to yield information important in prehistory or history.

Included in this category are sites which contain cultural deposits and therefore have excavation potential or have well-defined surface features which could yield information from further study.

Included are habitation sites as well as agricultural features whose excavation and further mapping and recording can shed light on chronology and sequence of prehistoric land development. Prime examples of sites in this category are the lava tube caves.

E. Site has cultural significance to the Hawaiians or other ethnic group.

This category includes religious sites - heiau - and sites containing human burials. There are 8 sites likely to contain burials. Other sites, particularly habitation sites, are also potential burial sites.

F. Not Significant (NS) - These are sites which do not fit any of the above criteria, but are still listed for recording purposes. Included are minimally modified natural features and modern shelters.

G. No longer Significant (NLS) - These sites were significant only under Criterion D for their informational content, but all information necessary has been recorded. Included are isolated rock mounds, _ahu_, and sites which are disturbed to the point of bare recognition. There are a total of 12 sites which are listed in Table 1 as NS or NLS which leaves 63 significant sites on the property of a total of 75.

Table 1

SUMMARY LIST OF ARCHAEOLOGICAL SITES

Field No	State No	Description	Work Done	Significance	Preliminary Mitigation
CSH135	86	(Bennett) Habitation Platform	Surveyed& Mapped 1985	C, D	Pres D
CSH4	900	Habitation Platform	Surveyed	C, D	Pres, Int.
CSH5	901	Ag.mounds,wall	Surveyed 1985	D	Data Rec.
CSH6	902	C-shaped shelter	Surveyed 1985, Tested 1985, C14 samples collected	D	Data Rec.
CSH7	903	C-shaped shelter collapsed	Surveyed 1985	D	Data Rec.
CSH8	904	C-shaped shelter small	Surveyed 1985	D	Data Rec.
CSH9	905	C-shaped shelter	Surveyed 1985	D	Data Rec.
CSH101	906	Ag.features, walls mounds	Surveyed 1990	NLS	None
CSH102	907	L-shaped wall	Surveyed 1990	NLS	None
CSH103	908	Modified Outcrop	Surveyed mapped 1990	D	Data Rec.
CSH104	909	Modified Outcrop	Surveyed mapped 1990	D	Data Rec.
CSH105	910	C-shaped shelter	Surveyed 1990	NLS	None
CSH106	911	C-shaped shelter remnant	Surveyed 1990	NLS	None
CSH107	912	C-shaped shelter remnant	Surveyed 1990	NLS	None
CSH108	(field # not assigned)				

CSH109	913	Ag/Habitational Complex w/ assoc. _'auwai_ & platform	Surveyed mapped 1990	C,D	Pres. Int.
CSH110	914	Ag.mound	Surveyed mapped 1990	NLS	None
CSH111	915	L-shaped terrace	Surveyed mapped 1990	D	Data Rec.
CSH112	916	Mound	Surveyed mapped 1990	NLS	None
CSH113	917	U-shaped mound	Surveyed mapped 1990	D	Data Rec.
CSH114	918	Habitation platform	Surveyed mapped 1990	D	Data Rec.
CSH115	919	Large mound, internal features	Surveyed mapped 1990	D,E*	Data Rec. Pres. Burial?
CSH116	920	_'Auwai_	Surveyed mapped 1990	D	Data Rec.
CSH117	921	_'Auwai_ section	Surveyed mapped 1990	D	Data Rec.
CSH118	(Part of 929)				
CSH125	922	_'Auwai_ section	Surveyed mapped 1990	D	Data Rec.
CSH119A-C	923A-C	Ag.walls,shelter	Surveyed mapped 1990	D	Data Rec.
CSH119D	924	C-shape, shelter	Surveyed mapped 1990	D	Data Rec.
CSH119E	925	Enclosure	Surveyed mapped 1990	D	Data Rec.
CSH120	926	Ag.fields & ranching complex	Surveyed mapped 1990	C, D E* (E* for Fea. D)	Fea.E test Pres. Burial? Data Rec.
CSH121A	927	Mound	Surveyed mapped 1990	D,E*	Data Rec. Pres. Burial?
CSH121B	928	Mound	Surveyed mapped 1990	D	Data Rec.
CSH122	929	_'Auwai_ section	Surveyed mapped 1990	D	Data Rec.

CSH123	930	'Auwai section	Surveyed D mapped 1990	Data Rec.
CSH124	931	'Auwai section	Surveyed D mapped 1990	Data Rec.
CSH125	932	Walls, enclosure	Surveyed D mapped 1990	Data Rec.
CSH126	933	Wall	Surveyed NLS mapped 1990	None
CSH127A	934	Wall	Surveyed C mapped 1990	Data Rec.
CSH127B	935	Mound	Surveyed NLS mapped 1990	None
CSH128	936	Mound with paving	Surveyed D,E* mapped 1990	Data Rec. Pres. Burial?
CSH129	937	Wall	Surveyed NLS mapped 1990	None
CSH130	938	Wall & 'auwai	Surveyed C,D mapped 1990	Pres. Int.
CSH131	939	Lava tube shelter	Surveyed D,E* mapped 1990	Pres Burial Test deposits
CSH132A	940	Mound, shelter & wall	Survey D,E* mapped 1990	Data Rec. Pres. Burial?
CSH132B	(See 940)			
ARCH421	941	'Auwai	Surveyed 1986 D mapped 1990	None
CSH133	942	Wall & habitational enclosure	Surveyed D mapped 1990	Data Rec.
CSH134	943	'Auwai section	Surveyed D mapped 1990	Data Rec.
CSH6	944	Ag mounds & modified outcrops	Surveyed NLS mapped 1990	None
CSH136	945	Corral & 'auwai Ag. Walls	Surveyed D mapped 1990	Data Rec. Recovery
CSH137	946	Lava tube	Surveyed C,D,E mapped 1990	Pres. Burial Test deposits
CSH138	947	Railroad berm	Surveyed C,D mapped 1990	Pres. Int.

ARCH420	948	Walled Complex	Surveyed 1978 Resurveyed 1990	C,D	Data Rec.
ARCH420A	949	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH420B	950	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH420C	951	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH421	952	Platform	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH422	953	Platform	Surveyed 1978 Resurveyed 1990	D,E*	Pres. Burial
ARCH423	954	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH423A	955	Mound	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH424A	956	C-shaped shelter	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH424B	957	C-shaped shelter & Platform	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH424C	958	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH424D	959	C-shaped shelters	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH425A	960	Shelters & low wall	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH425B	961	Shelters & Cupboard	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH426	962	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH427	963	Ag. enclosure & low mounds	Surveyed 1978 Resurveyed 1990	NLS	None
ARCH428	964	C-shaped shelter	Surveyed 1978 Resurveyed 1990	D	Data Rec.
ARCH429	965	2 adjoining C-shaped shelters & wall	Surveyed 1978 Resurveyed 1990	D	Data Rec.

ARCH430A	966	Ag. Complex, walls <u>lo'i</u>	Surveyed 1978 Resurveyed 1990	C,D	Pres. Int.
ARCH430B	967	C-shaped shelter	Surveyed 1978 Resurveyed 1990	D	Pres. D.
ARCH836	968	C-shaped shelters enclosure & wall	Surveyed 1978 Resurveyed 1985 Tested 1985 (C14 collected)	D	Data Rec.
CSH103	969	<u>'Auwai</u>	Surveyed Mapped 1990	D	Data Rec.
CSH104	970	Rocky Ag area	Surveyed mapped 1990	NLS	None
ARCH423	971	<u>'Auwai</u>	Surveyed 1978	D	Data Rec.
-	972	<u>'Auwai</u>	Surveyed 1978 mapped 1990	D	Data Rec.
ARCH430A	973	<u>'Auwai</u>	Surveyed 1978 mapped 1990	D	Data Rec.

<u>CODES FOR CRITERIA FOR SITE SIGNIFICANCE</u>

NS Not Significant

NLS No Longer Significant

A Site reflects major trends or events in the history of the state or nation

B Site is associated with the lives of persons significant in our past

C Site is an excellent example of a site type.

D Site may be likely to yield information important in prehistory or history.

E Site has cultural significance; probable religious structures (shrines, <u>heiau</u>) and/or burials present

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* Signifies site is only a possible burial or religious feature.

CODES FOR PRELIMINARY MITIGATION

Pres. Int. = Preservation with Interpretation

Pres. Burial = Preservation of Burial

Pres. D	=	Preservation for information content
Data Rec.	=	Site to be data recovered

Table 2: Po'ipulani Sites by Functional Categories and Age

State Site No.	Description	PH	TH	'auwai	Ag.site	Burial	Cave	Other	Pre-his toric	Post Contact	Comments
50-30-10 86	Habitation Platform	x							x	x	
50-30-10 900	Habitation Platform	x							x		
50-30-10 901	Ag. mounds, wall				x				x		
50-30-10 902	C-shaped shelter		x						x		
50-30-10 903	C-shaped shelter collapsed		x						x		
50-30-10 904	C-shaped shelter small		x						x		
50-30-10 905	C-shaped shelter		x						x		
50-30-10 906	Ag. features, walls, mounds		x		x				x		
50-30-10 907	L-shaped wall		x		x				x		
50-30-10 908	Modified outcrop		x						x		
50-30-10 909	Modified outcrop		x						x		
50-30-10 910	C-shaped shelter		x						x		
50-30-10 911	C-shaped shelter remnant		x						x		
50-30-10 912	C-shaped shelter remnant		x						x		
50-30-10 913	Ag/Habitation Site w/ 'auwai & platform		x	x	x				x		
50-30-10 914	Ag. mound				x				x		
50-30-10 915	L-shaped terrace		x						x		
50-30-10 916	Mound				x				x		
50-30-10 917	U-shaped mound				x				x		
50-30-10 918	Habitation Platform	x							x	x	
50-30-10 919	Large mound, internal features		x			x(?)			x		
50-30-10 920	'Auwai			x					x	x	
50-30-10 921	'Auwai section			x					x	x	
50-30-10 922	'Auwai section			x					x	x	
50-30-10 923	Ag. walls, shelter		x		x				x	x	
50-30-10 924	C-shape, shelter		x						x		
50-30-10 925	Enclosure		x						x		
50-30-10 926	Ag. fields & ranching complex		x(G)	x(F)		x(D)			x	x	
50-30-10 927	Mound				x	x(?)			x		
50-30-10 928	Mound				x				x		
50-30-10 929	'Auwai section			x					x	x	
50-30-10 930	'Auwai section			x					x	x	
50-30-10 931	'Auwai section			x					x	x	
50-30-10 932	Walls, enclosure		x		x				x		

PH - Permanent Habitation TH - Temporary Habitation

Table 2: Po'ipulani Sites by Functional Categories and Age

State Site No.	Description	PH	TH	'auwai	Ag.site	Burial	Cave	Other	Pre-historic	Post Contact	Comments
50-30-10 933	Wall				x				x	x	
50-30-10 934	Wall				x					x	
50-30-10 935	Mound				x				x		
50-30-10 936	Mound w/ paving				x	x?			x		
50-30-10 937	Wall				x						
50-30-10 938	Wall & 'auwai			x	x				x	x	
50-30-10 939	Lava tube shelter		x			x	x		x	x	
50-30-10 940	Mound shelter & wall				x	x?			x		
50-30-10 941	'Auwai			x					x	x	
50-30-10 942	Wall & habitation enclosure	x			x					x	
50-30-10 943	'Auwai section			x					x	x	
50-30-10 944	Ag mounds & modified outcrops				x				x		
50-30-10 945	Ag. walls & 'auwai			x	x				x	x	
50-30-10 946	Lava tube	x				x	x		x		
50-30-10 947	Railroad berm							x		x	
50-30-10 948	Walled complex		x		x				x	x	
50-30-10 949	Enclosure		x						x		
50-30-10 950	Enclosure				x					x	
50-30-10 951	Enclosure		x							x	
50-30-10 952	Platform	x							x		
50-30-10 953	Platform	x				x			x		
50-30-10 954	Enclosure	x							x		
50-30-10 955	Mound								x		
50-30-10 956	C-shaped shelter		x						x		
50-30-10 957	C-shaped shelter & platform		x						x		
50-30-10 958	Enclosure		x						x		
50-30-10 959	C-shaped shelters		x						x		
50-30-10 960	Shelters & low wall		x						x		
50-30-10 961	Shelters & cupboard		x						x		
50-30-10 962	Enclosure			x					x		
50-30-10 963	Ag. enclosure & low mounds				x				x		
50-30-10 964	C-shaped shelter			x					x		
50-30-10 965	'2 adjoining C-shaped shelters & wall			x	x				x		

Table 2: Po'ipulani Sites by Functional Categories and Age

State Site No.	Description	PH	TH	'auwai	Ag.site	Burial	Cave	Other	Pre-his toric	Post Contact	Comments
50-30-10 966	Ag. complex, walls, lo'i				x				x		
50-30-10 967	C-shaped shelter		x						x	x	
50-30-10 968	C-shaped shelters, enclosure & wall		x						x		
50-30-10 969	'Auwai			x					x		
50-30-10 970	Rocky Ag. area				x				x		
50-30-10 971	'Auwai			x					x	x	
50-30-10 972	'Auwai			x					x	x	
50-30-10 973	'Auwai			x					x	x	

VI. RECOMMENDATIONS

In spite of extensive historical modification of land for cane cultivation and pasture improvement, a large number of significant archaeological sites still remain in the uncultivated portion of the project area. These sites are variably significant in accordance with the criteria described above. Mitigation of the significant sites can be undertaken by two possible actions:

1. preservation of sites in place for future generations, either by simple physical preservation or preservation with interpretation.
2. further study including subsurface testing and excavation preceding development impact and removal of sites.

Considering the variable significance and the different criteria applied to this significance, as well as a number of practical issues, it is only possible to preserve some sites - the most culturally significant and some of the best preserved examples of sites. The scientific and historical significance can be addressed through further study.

Therefore, the following steps are proposed:

1. Physical Preservation of all or parts of the most well-preserved agricultural/habitation complexes which best represent former Hawaiian use of the land. These complexes are Sites 913 and 966.
2. Physical Preservation of well-preserved, excellent examples of habitation sites. Included in this category is Site 86, recorded by Bennett in the late 1920s, and Site 900, another habitation platform.

3. The physical preservation of both lava tube cave sites, Sites 939 and 936, not only because of their archaeological significance but because they almost certainly contain burials. All areas above the tube chambers should be kept as open space.

4. The physical preservation of all other sites which are likely to contain burials or which testing shows to contain burials. Site 953 should definitely be preserved without testing because of the high probability of burial in the rock fill of the platform.

5. The physical preservation of portions of Site 947, the railroad berm. The berm is best preserved at its western end.

6. The physical preservation of some of the well-preserved walls. The best examples are found at Sites 934 and 938. These walls are representative of the past use of the land and reflect the unique character of the traditional Kōloa landscape.

7. The physical preservation of any other sites which can possibly be incorporated into the development landscaping and designated as open areas.

8. All significant archaeological sites not designated for preservation should be subjected to a program of subsurface testing followed by intensive excavation of selected sites and features to address scientific/informational significance. The majority of the habitation sites and features and samples of agricultural features should at least be tested. Any possible burial sites not previously recommended for preser-

vation could be tested with evaluation following the results of excavation.

All phases of archaeological work should be coordinated with the Kaua'i County Historic Sites Commission and the State Historic Preservation Office. The testing and excavation should be undertaken according to a data recovery plan prepared by an archaeologist and reviewed by these agencies. Preservation of sites should also be undertaken according to a preservation plan prepared by an archaeologist and approved by the same agencies.

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Appendix D

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING, ROOM 555
601 KAMOKILA BOULEVARD
KAPOLEI, HAWAII 96707

June 15, 2005

Hal Hammatt, Ph.D.
Cultural Surveys Hawaii
P.O. Box 1114
Kailua, Hawaii 96734

LOG NO: 2005.1208
DOC NO: 0506NM16

Dear Dr. Hammatt:

SUBJECT: **Historic Preservation Review –Revised Archaeological Inventory Survey for the Makai Portions of Parcel 19 of the Eric A. Knudsen Trust Lands, Koloa (Hammatt, Cordy, Rainalter, Gomes, Shideler and Folk, CSH, 2005) Koloa, Koloa, Kauai**
TMK: (4) 2-18-14: 19 por.

Thank you for submitting the above revised report for our review which received on May 14, 2005. This report is for an 18-acre project area. A total of 33 historic properties were known to have existed in the 18-acre project area. The age ranges were from 1330-1660 A.D. and 1670-1950 A.D.

Fifteen sites (3766, 3769, 3770, 3771, 3775, 3779, 3785, 3790, 3791, 3896, 3897, 3898, 3899, 3900 and 3905) have been determined to be significant under criteria D of the National and State Registers. Sites 966 and 39000 are significant under criteria C and D.

You recommend no further archaeological work for sites 3771, 3775, 3779, 3896, and 3898 because these sites have been impacted by rock collecting, are in poor condition and do not merit preservation.

You are recommending data recovery for nine of the sites (3766, 3769, 3770, 3785, 3790, 3791, 3897, 3899, and 3905). In accordance with Hawaii Administrative Rules13-278 with you will need to submit a data recovery plan for review and approval by our office.

You are recommending that one site complex 966 and site 3900 be preserved. In accordance with Hawaii Administrative Rules 13-277 you will need to submit a preservation plan for site 966 and one for site 3900 which includes short and long term measures for review and approval by our office.

The revisions have been made, the report is acceptable. If you have any questions, please call Nancy McMahon 742-7033.

Aloha,

Melanie Chinen, Administrator
State Historic Preservation Division

NM:jen

c: Ian Costa, County Planning Department
KHPRC

Archaeological Inventory Survey

For the Makai Portion of Parcel 19 of the Eric A. Knudsen Trust Lands,

Kōloa Ahupuaʻa, Kona District, Kauaʻi

TMK: 2-18-14-19 por.

by

Jesse Yorck, B.A.,

Jonus Madeus, B.A.,

John E. Dockall, Ph.D.,

Sallee D.M. Freeman, M.A.,

and

Hallett H. Hammatt Ph.D.

Prepared for

Eric A. Knudsen Trust

by

Cultural Surveys Hawaiʻi, Inc.

May 2005

MANAGEMENT SUMMARY

Title	Archaeological Inventory Survey for the Makai Portion of Parcel 19 of the Eric A. Knudsen Trust Lands, Kōloa Ahupua‘a, Kona District, Kaua‘i (TMK 2-18-14: por. 19).
Date	May 2005 (Draft)
Project Number	Cultural Surveys Hawai‘i Inc. (CSH) Job Code: KOLO 24
Investigation Permit Number	CSH completed the inventory survey fieldwork under state archaeological permit No. 0404 issued by the State Historic Preservation Division (SHPD), per Hawai‘i Administrative Rules (HAR) Chapter 13-13-282.
Project Location	The project area comprises TMK 2-18-14: por. 19 which is bounded on the south by Po‘ipū Road, on the east by the Weliweli House Lots Subdivision, on the north by the proposed Phase I of the Village at Po‘ipū project area, and on the west by a landscaping operation’s base yard, in Kōloa Ahupua‘a, District of Kona, Island of Kaua‘i. This area is depicted on the 2000 Kōloa 7.5-minute USGS topographic quadrangle.
Project Land Jurisdiction	Private, Eric A. Knudsen Trust
Project Description	Eric A. Knudsen Trust proposes to develop portions of the 19-acre parcel as part of a residential, multifamily subdivision. Minimally, this would include grading, dwelling construction, and street and utility installation.
Project Acreage	Approximately 18 acres
Area of Potential Effect (APE)	For this inventory survey investigation, the project’s APE is defined as the entire approximately 18-acre footprint of the proposed subdivision development. The survey area and the project APE are one and the same.
Historic Preservation Regulatory Context	At the request of the landowner, the Eric A. Knudsen Trust, CSH undertook this archaeological inventory survey. In consultation with the SHPD, the inventory survey investigation was designed to fulfill the state requirements for archaeological inventory surveys [Hawai‘i Administrative Rules (HAR) Chapter 13-276].
Fieldwork Effort	Fieldwork was conducted by Gerald Ida, B.A., Missy Kamai, B.A. and Jonas Madeus, B.A., under the general guidance of Hallett H. Hammatt, Ph.D., between the dates of September 1 and 17, 2004.
Number of historic properties identified	16 historic properties were identified in the project APE, 15 were previously recorded (50-30-10-3766, -3769, -3770, -3771, -3775, -3779, -3785, -3790, -3791 -966, -3896, -3897, -3898, -3899, -3900), and one was newly identified (50-30-10-3905)
Historic Properties Recommended Eligible to the Hawai‘i Register of Historic Places (Hawai‘i Register)	SIHP Site 50-30-10-966, Agricultural and Habitation Complex, (C, D) SIHP Site 50-30-10-3766, Wall, C-shapes, and Mound, (D) SIHP Site 50-30-10-3769, Walls, Terrace, Enclosure, and Mound, (D) SIHP Site 50-30-10-3770, C-Shape and Terrace, (D) SIHP Site 50-30-10-3771, Mound, (D)

	SIHP Site 50-30-10-3775, Mound, (D) SIHP Site 50-30-10-3779, Enclosure, (D) SIHP Site 50-30-10-3785, Enclosure, (D) SIHP Site 50-30-10-3790, C-Shape, (D) SIHP Site 50-30-10-3791, Enclosure and Platform, (D) SIHP Site 50-30-10-3896, Wall, (D) SIHP Site 50-30-10-3897, C-Shape, (D) SIHP Site 50-30-10-3898, Mound, (D) SIHP Site 50-30-10-3899, Enclosure, (D) SIHP Site 50-30-10-3900, Wall, (C, D) SIHP Site 50-30-10-3905, C-Shapes, Terrace, (D)
Effect Recommendation	The proposed subdivision development will adversely affect significant historic properties 50-30-10-3766, -3769, -3770, -3771, -3775, -3779, -3785, -3790, -3791, -3896, -3897, -3898, -3900, 3905 and possibly -3899. The recommended mitigation measures will reduce the project's effect to these historic properties.
Mitigation Recommendation	SIHP Site 50-30-10-966, Remnant Agricultural and Habitation Complex, Preserve remnant portions SIHP Site 50-30-10-3766, Wall, C-Shapes and Mound, Data Recovery SIHP Site 50-30-10-3769, Walls, Terrace, Enclosure and Mound, Data Recovery SIHP Site 50-30-10-3770, C-Shape and Terrace, Data Recovery SIHP Site 50-30-10-3771, Mound, No Further Work SIHP Site 50-30-10-3775, Mound, No Further Work SIHP Site 50-30-10-3779, Enclosure, No Further Work SIHP Site 50-30-10-3785, Enclosure, Data Recovery SIHP Site 50-30-10-3790, C-Shape, Data Recovery SIHP Site 50-30-10-3791, Enclosure and Platform, Data Recovery SIHP Site 50-30-10-3896, Wall, No Further Work SIHP Site 50-30-10-3897, C-Shape, Data Recovery SIHP Site 50-30-10-3898, Mound, Data Recovery SIHP Site 50-30-10-3899, Enclosure, Data Recovery SIHP Site 50-30-10-3900, Wall, Preserve SIHP Site 50-30-10-3905, C-Shapes, Terrance, Data Recovery

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I. INTRODUCTION

A. Project Background

At the request of the landowner, the Eric A. Knudsen Trust, Cultural Surveys Hawai‘i Inc. (CSH) conducted this archaeological inventory survey. In consultation with the State of Hawai‘i Department of Land and Natural Resources / State Historic Preservation Division (DLNR / SHPD), the inventory survey investigation was designed to fulfill the state requirements for archaeological inventory surveys [Hawai‘i Administrative Rules (HAR) Chapter 13-276].

The approximately 18-acre parcel, known as the *makai* portion of parcel 19 of the Eric Knudsen Trust Lands comprises TMK 2-18-14: por. 19, and is located in Kōloa Ahupua‘a, District of Kona, Island of Kaua‘i (Figures 1, 2). The parcel is bounded on the south by Po‘ipū Road, on the east by the Weliweli House Lots Subdivision, on the north by the proposed Phase I of the Village at Po‘ipū project area, and on the west by a landscaping operation’s base yard. This area is depicted on the 2000 Kōloa 7.5-minute USGS topographic quadrangle. The project area is currently being utilized as grazing land for cattle.

The Eric A. Knudsen Trust proposes to develop portions of the 18-acre parcel as part of a residential, multifamily subdivision. Minimally, this would include grading, dwelling construction, and street and utility installation. For this inventory survey investigation, the project’s Area of Potential Effect (APE) is defined as the entire approximately 18-acre footprint of the proposed subdivision development.

The project area was originally surveyed and described as part of the archaeological survey in support of the then proposed Kiahuna Golf Village project by the Archaeological Research Center Hawai‘i (ARCH) (Hammatt et al. 1978). The current project area was covered as the *makai* (southern) portion of the Kiahuna survey area designated “Area C”. Sites were located and described with no subsurface testing. Both habitation and agricultural sites were located in the current project area, including stone enclosures, platforms, *‘auwai* (irrigation ditches), and terraced plots.

The eastern portion of the current project area was resurveyed by CSH as part of the archaeological survey for the proposed Kōloa-Po‘ipū Bypass Road project (Hammatt et al. 1985). Archaeological work was completed, however the plans for the road alignment were abandoned and a completed survey report was never submitted to the SHPD / DLNR.

In 2003, the current project area was subjected to a field inspection by CSH archaeologists (Tulchin and Hammatt). Pedestrian inspection of the project area indicated disturbed areas including large boulder piles, fenced enclosures, and bulldozed roads that were not present in the 1978 or 1985. Existing sites in the vicinity of the various disturbed areas were located and their condition assessed. Sites within the interior of the disturbed areas were assumed to have either been covered or destroyed. A comprehensive description of the findings of the Tulchin and Hammatt (2003) study can be found in Section III, entitled “Previous Archaeological Research.”

Based on the varying levels of documentation and the observation that certain sites have been destroyed and/or severely impacted, the SHPD / DLNR requested an inventory survey plan be developed for review and approval prior to conducting the required inventory survey. The Inventory Survey Plan (Hoffman et al. 2004) was reviewed and approved (LOG No. 2004.2666, Doc No. 0408NM19). Based on the survey plan the following scope of work was implemented.

Figure 1. Portion of 7.5-minute U.S. Geological Survey map, Kōloa Quad (2000), showing location of project area

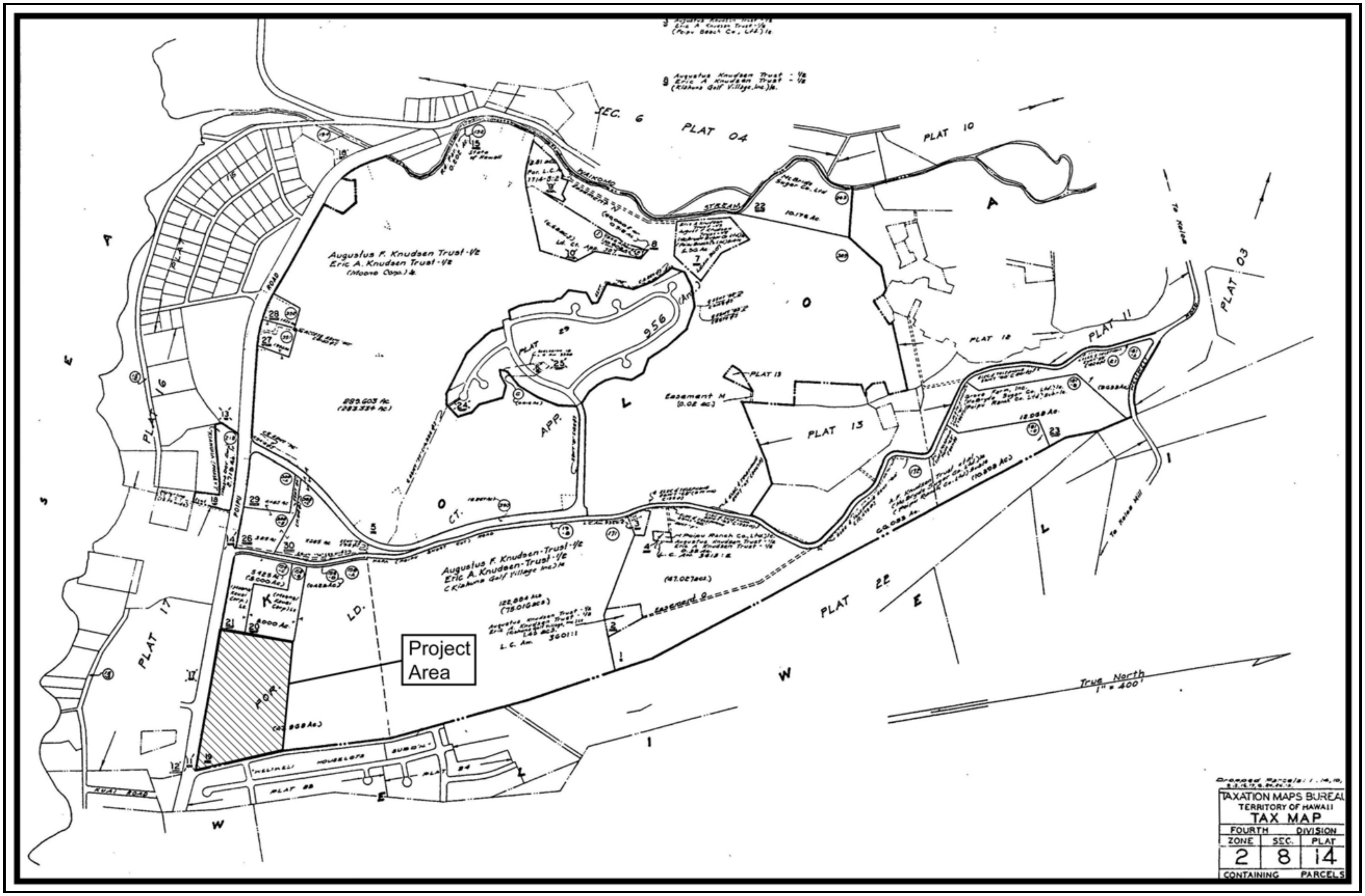


Figure 2. Portion of TMK 2-8-14 showing the location of the survey area

B. Scope of Work

The scope of work for this archaeological inventory survey included:

1. A complete ground survey of the entire project area for the purpose of site inventory. All previously identified sites were relocated, if possible, mapped, photographed and described. Any features not previously documented were described, mapped, and assigned State Inventory for Historic Preservation (SIHP) numbers, if appropriate.
2. Subsurface testing through hand excavation of a sample of sites and/or features. The selections were made based on the state of preservation of the site or feature and the potential for yielding information. Testing focused on gaining a representative sample of site and feature types and function. When appropriate samples from these excavations were found, they were analyzed for chronological and paleoenvironmental information. Documentation included photographs and scale drawings.
3. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award (LCA) documents. This research focused on the specific area with general background on the *ahupua'a* and district and emphasized settlement patterns.
4. Preparation of a survey report which includes the following:
    a. A topographic map of the survey area showing all archaeological sites and site areas;
    b. Description of all archaeological sites with selected photographs, scale drawings, and discussions of function;
    c. Historical and archaeological background sections summarizing pre-contact and historic land use as they relate to the archaeological features;
    d. A summary of site categories and their significance in an archaeological and historic context;
    e. Recommendations based on all information generated specifying what steps should be taken to mitigate impact of development on archaeological resources. These recommendations were developed in consultation with the client and the State agencies.

C. Natural Setting

The project area is situated approximately 400 m inland (*mauka*) of shoreline at an elevation of approximately ten to forty feet (3 m to 12 m) above mean sea level, on the southern coast of Kauaʻi in the *ahupua'a* of Kōloa in the district of Kona. Waikomo Stream, approximately 1.5 km to the northwest, is a perennial stream and is the primary source of surface water in Kōloa.

The soil mantle in the project area is identified as very rocky Waikomo silty clay. It is aptly described as present on slopes ranging from two to six percent and having a representative profile comprised of a surface layer of dark grayish brown stony silty clay 14 inches thick, a six inch thick subsoil layer of reddish stony silty clay, and hard rock substratum (Foote et al. 1972).

Rainfall averages between 30 and 40 inches a year (Armstrong 1973); prevailing winds are from the northeast, and temperatures range from about sixty-to-ninety degrees Fahrenheit throughout the year. This dry environment with shallow soil today supports predominantly *koa haole* (*Leucaena glauca)* and *kiawe* (*Prosposis pallida*), exotic grasses, weeds and some grasses, though cattle grazing in the project area have kept the vegetation in check.

D. Methods

1. Field Methods

Fieldwork was conducted by Gerald Ida, B.A., Missy Kamai, B.A. and Jonas Madeus, B.A., under the general guidance of Hallett H. Hammatt, Ph.D., between the dates of September 1 and 17, 2004. The field survey included collection of GPS data, mapping, and test excavations of sites and features in the project area. Fieldwork was performed under CSH's annual archaeological research permit, No. 0404, issued by the DLNR / SHPD.

The surface survey covered 100% of the project area. All previously identified sites were relocated, if possible, mapped, photographed and described. Field personnel utilized site descriptions from previous research in the project area (Hammatt et al. 1978; Hammatt et al. 1985; Hammatt 1991; Hammatt et al. 1991) to make note of changes in site integrity over time. The project director employed this information to make site significance determinations. In addition, any features not previously documented were described, mapped, and assigned State Inventory for Historic Preservation (SIHP) numbers, if appropriate.

The following methods were used in accomplishing test excavations:

1) Excavated sediments were screened through 1/8 inch mesh screen.
2) All artifacts and shell, bone, and botanical midden were recovered from the screens.
3) In situ charcoal samples and charcoal samples were recovered from screening of sediments and collected for radiocarbon dating and wood species identification as appropriate.
4) A minimum of one stratigraphic profile from each excavation unit was recorded by scale drawing. This profile drawing shows stratigraphic relationships between structural elements and sediment layers.
5) All trenches were excavated to culturally sterile sediments or bedrock.
6) Cultural strata was excavated in 10 cm levels were applicable.

2. Mapping

Global Positioning System (GPS) data was collected for all sites and features identified in the project area and will be made available to SHPD for inclusion in the State Database. Scale maps of the project area showing all remaining sites and features are included in the inventory survey report.

3. Laboratory Methods

This phase of work involved the following specific procedures:

1) Identification and cataloguing of artifactual material including both historic and prehistoric forms was completed. Spatial and functional analyses was performed on the assemblages of each feature and cluster of features to examine the type and extent of

activities taking place in each feature and cluster. Artifacts, if found, are to be measured with representative samples drawn and/or photographed.

2) Midden was identified to genus and species, weighed, and analyzed. Depth and stratigraphic data was tabulated for each sample from each excavation unit.
3) Appropriate charcoal samples were submitted for radiocarbon dating. Two samples were dated.

II. HISTORICAL BACKGROUND

A. Mythological and Traditional Accounts

There are several place names within Kōloa that have names and legendary associations. The name Kōloa itself has several derivations. Kōloa is the name for the large soft Hawaiian sugar cane (*Saccharum officinarum*) once grown by the Hawaiians; Kōloa is also the name of a steep rock on the banks of Waikomo Stream, from whence the *ahupuaʻa* got its name. This bank of the river was called Kōloa, after the native Hawaiian duck (*Anas wyvilliana*) (Kikuchi 1963:46; Pukui et al. 1974:116).

Mau-lili (meaning constant jealousy) is a deep pool in Waikomo (lit. "entering water") Stream. When the gods Kāne and Kanaloa first came to Kauaʻi, they explored the island and came to the pool of Maulili at evening. They stretched out beside the pool for their night's sleep on its eastern bank and left the impression of their forms as can be seen in the *apapa* (a flat area). The Maulili Heiau was first built by Ka-pueo-maka-walu, the son of Kapu-lau-kī. It was a place of human sacrifice (Wichman 1998:12). This *heiau* may be the Maulili Heiau described by Makea in the Lahainaluna document mentioned above. "The apapa in this vicinity is called an 'Unu' and a 'Heiau', but was never walled in, it is said. On the nights of Kāne the drums are heard to beat there, also at the sacred rocks, or unu's, of Opuokahaku and Kanemilohae, near the beach of Poʻipū" (Farley 1907).

There are additional legends associated with the Maulili area.

> In the Maulili pool lived a large moʻo [water spirit], named 'Kiwahine'…The eastern wall of the pool, just below the resting places of Kane and Kanaloa, for a short distance, only, is called the 'Pali of Kōloa." The District of Kōloa is named for this Pali, we are told be old Hawaiians. To the south of the Palo o Kōloa, in the wall is a rock named 'Waihānau' [meaning birth water'…as one of their meles has it:
>
> Aloha wale ka Pali o Kōloa,
> Ke Ala huli I Waihānau e, hanau
>
> To the south of Waihānau is a projecting rock named 'Ke elelo o ka Hawai'i—the tongue of Hawaiʻi, said to have been wrested and brought from Hawaiʻi by the Kauaʻi warrior Kawelo, of Wailua.
>
> At the southern end of the Maulili pool started two large 'auwai's [irrigation ditches], that watered the land east and west of Kōloa [Farley 1907:93].

Thus, this sacred legend-imbued locus was the source that gave life to the lowland taro patches of Kōloa. These special associations would not have been lost on the Hawaiians dependent upon those waters. While taro would have been essential to the life of the *ahupuaʻa*, other resources were available. Bernice Judd, writing in 1935, summarizes most of what was known—into the first decades of this century—of the traditional life of Kōloa:

> In the old days two large *'auwai* or ditches left the southern end of the Maulili pool to supply the taro patches to the east and west. On the *kuaunas* [embankments] the natives grew bananas and sugar cane for convenience in irrigating. Along the coast they had fish ponds and salt pans, ruins of which are still to be seen. Their dry land farming was done on the *kula*, where they raised sweet potatoes, of which both the tubers and the leaves were good to eat. The Hawaiians planted *pia* [arrowroot] as well as *wauke* [mulberry] in patches in the hills wherever they would grow naturally with little cultivation. In the uplands they also gathered the leaves of the *hala* [screwpine] for mats and the nuts of the *kukui* [candlenut] for light [Judd 1935:53].

B. Early Historic Period

Early historical and ethnographic information suggest that Kōloa was well populated during the late pre-contact period. The earliest explorers, like Cook and Vancouver, used Waimea for anchorage and described the well-maintained, watered agricultural systems on that dry leeward coast. Captain Cook noted,

> What we saw of their agriculture, furnished sufficient proofs that they are not novices in the art. The vale ground has already been mentioned as one continuous plantation of taro, and a few other things, which have all the appearance of being well attended to [Cook et al. 1818].

In 1792 Vancouver visited the island, and recorded of the surrounding countryside: "…the low country which stretches from the foot of the mountains toward the sea [is] occupied principally with the taro plant, interspersed with some sugar-canes of luxuriant growth and some sweet potatoes (Vancouver 1798)."

Although Ladd and Company went bankrupt in 1845, it went through a succession of individual and partnership owners, and was finally incorporated as the Kōloa Sugar Company in 1880. In 1882, the Kōloa Sugar Co. announced the construction of a railroad plant, consisting of four miles of 3-inch gauge track, and a 210-foot train consisting of forty cars and one locomotive (Conde and Best 1973:159). The first tracks were probably laid between the cane fields and the sugar mill. By 1910, the rails extended to Kōloa Landing where the steamers transported the bags of sugar to the mainland. In 1910, the *San Francisco Chronicle* commented:

> Cane is transported from the fields to the mill over a railroad system that consists of fifteen miles of permanent track, two miles of portable track, 250 cane cars and four locomotives. About two miles from the mill and connected with by rail is the steamer landing, with a warehouse that will hold 20,000 bags of sugar [cited in Conde and Best 1973:159].

C. Mid-1800s-Māhele Era

Ethnographic and historical information on the early post-European contact period is sketchy. The *ahupua'a* of Kōloa was controlled by the ruling chief of Kaua'i and was administered by lesser chiefs appointed by him (Kikuchi n.d.). When Ka-umu-ali'i, last of the ruling chiefs of the island, died in 1824, his lands, the lands of Kaua'i and Ni'ihau, were given to Kamehameha who then redistributed them among friends and members of the royal court. By the mid-nineteenth century, control of the *ahupua'a* was divided between Kamehameha III and Moses Kekūāiwa (Alexander 1937). The Māhele records indicate that Kōloa Ahupua'a (8,620 acres) was awarded to Moses Kekūāiwa (LCA 7714-B), the brother of Alexander Liholiho (Kamehameha IV), Lot Kapuāiwa (Kamehameha V), and Victoria Kamāmalu. One segment was leased to Ladd and Company in the 1830s for sugar cane cultivation. At the time of the Great Māhele, a number of *kuleana* (small holdings) were granted for homesteading and farming (Office of the Commissioner of Public Lands 1929).

Eighty-eight kuleana were awarded to individuals within Kōloa Ahupuaʻa. the majority of the Land Commission Awards (LCAs) were located in or around Kōloa town itself and the rest along Waikomo Stream. This concentration of awards around the town and stream may reflect the traditional land settlement patter, a focus on the resources of Maulili Pool and Waikomo Stream, and a more recent movement of the populace to the plantation and missionary centers. No individual *kuleana* were awarded in the project area.

A Hawaiian subject by the name of Lae stated a claim in January 1848 for 2 LCAs in close proximity to the current project area (LCA 3268:1, 3268:2 and 3268:3). The claimant received his lands from Kauhi in the days of Kaʻahumanu. Lae appears to have been awarded a house lot on the shore (LCA 3268:1) and an agricultural lot to the north, which abuts the project area (LCA 3268:2 or 3). The agricultural lot consisted of three *loi* (taro fields) and a *kula* (cane field).

D. Mid to Late 1800s

Systematic historic records in Kōloa began with the founding of the American Protestant Mission. On December 31, 1834 Reverend Peter Gulick and his family arrived in Kōloa. Apparently the first foreigners to settle in the *ahupuaʻa,* they initiated the process of rapid change that would reshape the life of Kōloa in the nineteenth century. In 1835, a 30 by 60 foot grass house was erected as a mission meeting house and school, probably located at Kōloa Town. Mr. Gulick also initiated sugar cane cultivation and collected a cattle herd for the Protestant Mission. In 1837, an adobe church was built and the first mission doctor, Thomas La Fon, arrived to assist Mr. Gulick. His successor, Dr. J.W. Smith reduced the cattle herd and sent 7,000 pounds of sugar grown on mission lands to Honolulu (Palama and Stauder 1973:22). The Kōloa mission station apparently flourished from its start. James Jackson Jarves, who visited Kōloa and Kauaʻi for nine months during the early 1840s, recorded:

> Kōloa is now a flourishing village. A number of neat cottages, prettily situated amid shrubbery have sprung up, within two years past. The population of the place, also, has been constantly increasing, by emigration from other parts of the island. It numbers, now, about two thousand people, including many foreigners, among whom are stationed a missionary preacher, and physician, with their families [Jarves 1844:100].

In 1834, two American naturalists, John K. Townsend and Thomas Nuttall, traveled to Kōloa in search of specimens. Townsend noted that from Kōloa Landing to the missionary station there were fields of taro, yam, and maize on both sides of the road. It is possible that he confused maize with Hawaiian cane. He observed irrigation networks, as well as sweet potato patches in the dryer areas. In many cases, these patches were protected with stone walls (Townsend 1839:206). Jarves also remarked on the fields of sugar cane, taro, yams, vegetables, indicating a more than usual attention to agriculture (1838:69).

A visitor in 1845 recorded other notable features of the landscape, including caves used for habitation. In his journal, Gorham Gilman (n.d.:11) describes "…some natural caves near the sea side." What he saw in one cave was only the most recent version of a scene that must have taken place there over countless generations:

> …looking round I saw a large hole in the ground near me, into which we descended by a pile of stones raised from the bottom for that purpose… here a strange sight met our view, there were some dozen or more natives seated around, some preparing a pig for the fire, other curing their tobacco and all engaged…making the place a natural kitchen [Gilman n.d.:11].

The first changes from the traditional agricultural and habitation patterns began in the 1830s when two sugar mills began production. Local Chinese erected a crude mill with granite rollers in the Māhāʻulepū area for grinding cane grown by the natives. This mill went out of business when a much larger mill operated by Ladd and Company began production a few years later. The mill and plantation operation resulted in an increase in immigration from other areas of Kauaʻi.

The advent of the Ladd and Company enterprise transformed Kōloa into a commercial center. Activity at Kōloa Landing at this time was described as the following:

> The port of Kōloa did a remarkable amount of trade considering the fact that the roadstead was not safe except when the trade winds blew. Most vessels preferred not to anchor but to lay off during the process of loading, rather than risk the chance of being wrecked by a sudden change of wind. An estimate in 1857 stated that 10,000 barrels of sweet potatoes were grown each year at Kōloa and that the crop furnished nearly all the potatoes sent to California from Hawaiʻi. Sugar and molasses were also chief articles of export [Judd 1935:325-326].

Other agricultural enterprises were attempted, however, none too successfully. Mulberry fields were started for silkworms, but succumbed to wind and drought. An attempt was made to develop a commercial market for *kukui* nut oil, but this failed as well. Tapioca was manufactured from cassava root during a brief period in the 1860s, but was apparently not commercially successful. By 1884, most of the land at Kōloa had been given over to sugar production.

Near the coast it appears that the effects of commercial cultivation were minimal. Clearing for cane cultivation occurred only along the banks of Waikomo Stream. Modifications to traditionally used agricultural fields are not clearly apparent, although substantial high walls superimposed on irrigated field walls and across *ʻauwai* channels suggest a change in land utilization from one of strict cultivation to one supporting both cultivation and ranching.

In the mid-1800s Kōloa became the scene of the confrontation between the traditional social structure and commercially propelled forces of change. The cane agriculture of Ladd and Company would inevitably affect the lives of the inhabitants in the rest of the *ahupuaʻa.* Traditional settlement patterns would have been distorted by a population shift to Kōloa Town where sugar cane milling activities were located. A shift from taro to cash crops also changed settlement patterns.

E. 1900s to Present

Kōloa Landing was phased out around 1925 when McBryde Sugar Company and Kōloa Sugar Company began using the alternative Port Allen. Soon after this, the sugar companies ceased to use the *makai* Kōloa fields, and the Knudsen family converted much of the area to cattle pastureland. A map of Kōloa Plantation (Figure 3) shows the extent of the sugar cane fields in 1935. Small patches of sugar cane grew along the east bank of Waikomo Stream, however no cane was grown in the current project area. The map also shows the railroad extending from Kōloa Mill to Kōloa Landing, along the northern border of the project area. In 1948, the Kōloa Sugar Company became part of the Grove Farm Company. Some inland areas of Kōloa remained under sugar cane cultivation until at least as late as the 1970s, when these cane lands were converted into pasture.

Specifically, the current project area is located immediately *mauka* (north) of Poʻipū Road, is bordered on the east by the Weliweli House Lots subdivision, to the west by the modern 1970s Kiahuna tennis courts, and extends *mauka* again to the southern boundary of the Proposed Poʻipūlani Golf Course project area (Hammatt et al. 1991).

The majority of the project area continues to be used as grazing land for cattle. The western portion of the project area is currently being utilized as a base yard for a landscaping (nursery) operation. A barbed-wire fence separates the nursery from the cattle grazing lands. Bulldozing activities in the current project area are evident, as there are multiple bulldozed roads in the central and eastern portions of the study parcel.

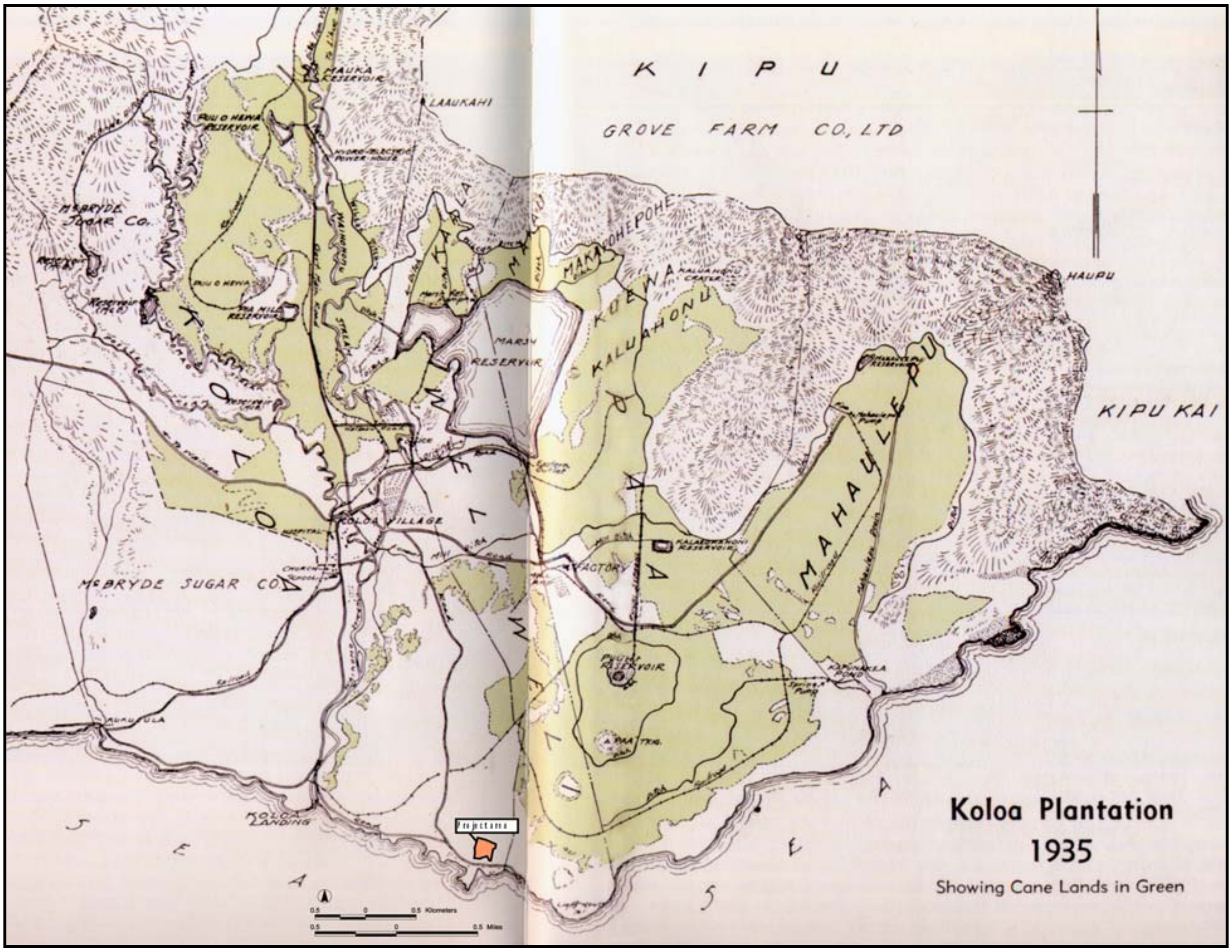


Figure 3. 1935 Map of Kōloa Plantation showing project area

III. PREVIOUS ARCHAEOLOGICAL RESEARCH

A. Previous Archaeology in Kōloa

Figure 4 and Table 1 summarize previous archaeological projects in the vicinity of the current project area.

Archaeological research before 1960 was limited to oral history accounts and surveys of the larger more important sites, especially coastal *heiau*. The first survey of an inventory nature of Kōloa resulted in a catalog of features for the general Kōloa region. The Lahainaluna Schools document lists 14 *heiau* and one fishing shrine in Kōloa Ahupuaʻa.

Thomas Thrum was the next to discuss sites in the Kōloa area in his list of the *heiau* of Kauaʻi. He noted six *heiau* in the district of Kōloa, which once extended from Hanapepe to Mahaulepu. The *heiau* were Hanakalauae, Kanehaule, Kihouna, Kaneiolouma, Weliweli (Weliweli Ahupuaʻa), and Waiopili (Mahulepu Ahupuaʻa). The two *heiau* on the Kōloa coast, Kaneiolouma and Kihouna, were described as: “near the Poʻipū Beach, at Kōloa, are two walled heiau but a short distance apart.” (Thrum 1907:36-37, 68)

Wendell Bennett conducted the earliest systematic archaeological survey of the island of Kaua’i in the late 1920s. Bennett examined and recorded 202 sites on the island, some in the *ahupuaʻa* of Kōloa, including the Kihouna Heiau (Bennett 1931:98).

William Kikuchi (1963) conducted a general survey of the Kona District of Kauaʻi including all *ahupuaʻa* from Hanapēpē, eastward to Kīpū Kai. Information from a number of sources (Lahainaluna School document 1885; Thrum 1907; Bennett 1931) was instrumental in helping to locate major archaeological sites during the field survey. Kikuchi’s survey was selective since it was not designed to be a complete inventory, and focused on larger or more coastal sites. No sites were near the present project area. Kikuchi did list sites that were not surveyed by him but were mentioned in other sources. In Kōloa, this included the *heiau* of Maulili.

During the 1973-1974 State Wide Inventory of Historic Places performed by the ARCH of the County of Kauaʻi for the State of Hawaiʻi, the archaeological remains first identified by Bennett (1931) (SIHP Site 50-30-10-85) were briefly evaluated and placed on Reserve status, meaning the sites needed to be saved until additional research could be carried out.

Stephen Palama and Catherine Stauder (1973) conducted a reconnaissance survey along the route of the then-proposed main cane haul road to the Kōloa mill site, *mauka* (inland) from the present project area. The proposed new section of road extended from Weliweli Road, southwestward across Poʻipū Road, connecting to an existing cane haul road. This road corridor crossed a portion of Weliweli Ahupuaʻa and both east and west Kōloa at a distance of between two-thirds to two miles from the coast. A total of 18 sites were recorded along the road corridor. Although the Palama and Stauder study was limited in scope to the proposed road right of way, it included a short but thorough historical summary of the place of archaeological sites within the context of the Kōloa and Weliweli Ahupuaʻa. An extensive *ʻauwai* system was observed east of Poʻipū Road. The following comments on this system and the sites in general are relevant to understanding the archaeological significance of the area as a whole, and the historic processes at work:

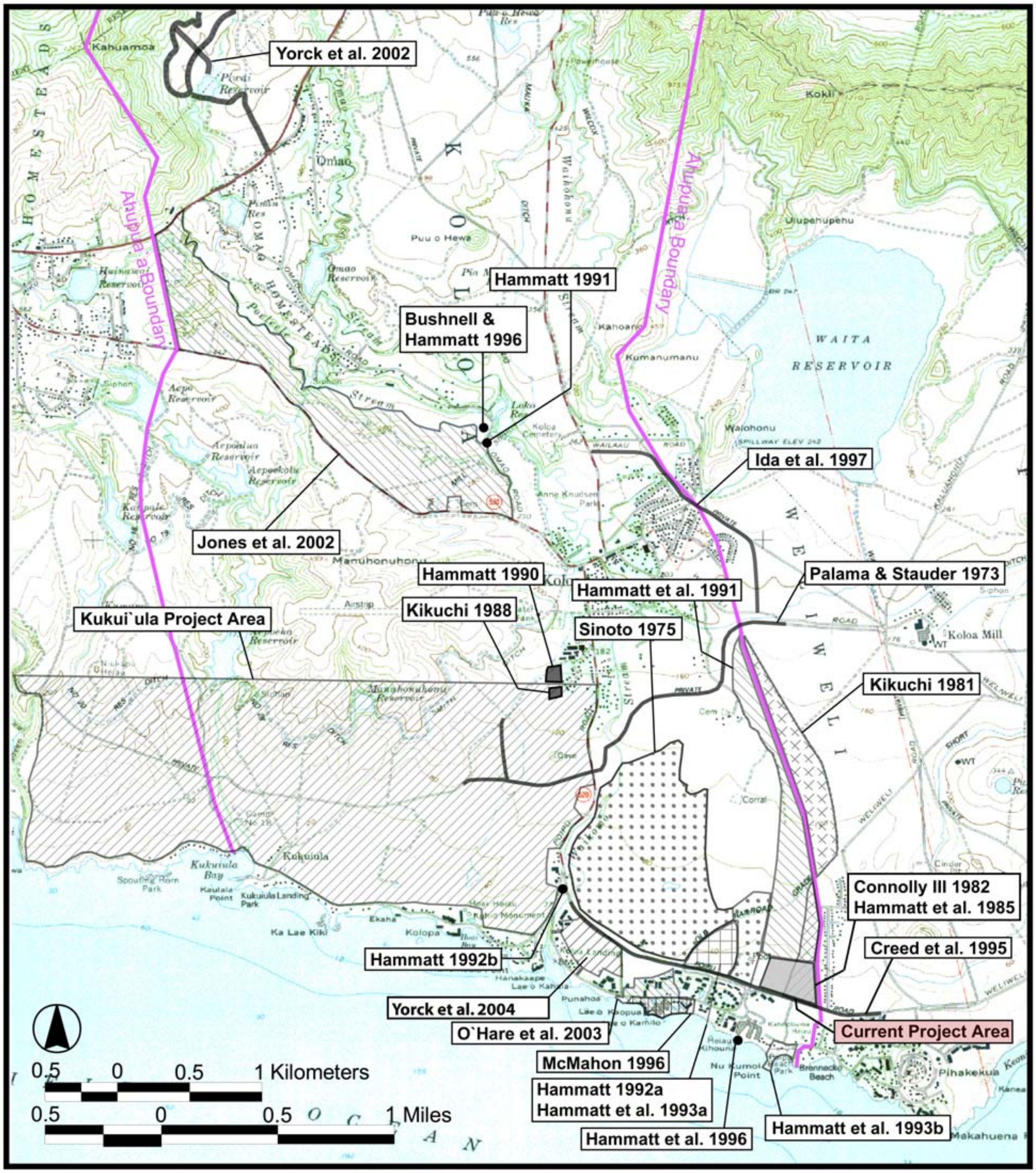


Figure 4. U.S. Geological Survey Map. Kōloa Quad (2000), showing project area and locations of previous archaeological studies

Table 1. Previous Archaeological Investigations in Kōloa Ahupuaʻa

NAME	YEAR	LOCATION	STUDY TYPE
Bennett	1931	Kukuiʻula Valley, Prince Kūhiō Park	General Survey
Kikuchi	1963	Kona District	General Survey
Kikuchi	1973	Hawaiian Fishponds	General Survey
Palama and Stauder	1973	Cane Haul Road-Kōloa Mill	Reconnaissance Survey
Sinoto	1975	Knudsen Trust Lands	Reconnaissance Survey
Bordner	1977	Kukuiʻula ʻAuwai, SIHP Site 50-39-10-1934	Reconnaissance Survey
Hammatt, Bordner and Tomonari-Tuggle	1978	Kīahuna Complex	General Survey
Kikuchi	1979	Sheraton Kauaʻi Hotel	Survey and Subsurface Testing
Connolly	1982	Kōloa-Poʻipū Bypass Road	Reconnaissance Survey
Ching	1983	Kukuiʻula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Landrum	1984	Kukuiʻula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Hammatt, Borthwick and Shideler	1985	Kōloa-Poʻipū Bypass Road	Survey and Subsurface Testing
Kikuchi	1985	Shoreline Improvements, Waiohai Hotel, Kiha Houna Heiau	Reconstruction
Kikuchi	1988	Paʻanau Sugar Camp	Reconnaissance Survey
Hammatt et al. (Hammatt, Borthwick, Shideler, and Stride)	1988	Kukuiʻula Bay Planned Community	Inventory Survey
McMahon	1989	Kauaʻi Fishponds	General Survey
Hammatt	1990	Paʻanau Housing Project	Inventory Survey
Hammatt	1991	Pōʻele'ele Stream - Waterline crossing	Archaeological Reconnaissance
Hammatt, Folk, and Stride	1991	Pōʻipulani Golf Course	Inventory Survey
Hammatt	1992a	Kīahuna	Inventory Survey
Hammatt	1992b	Poʻipū Road and Lāwaʻi Road Junction	Archaeological Reconnaissance
Hammatt, Ida and Folk	1993a	Poʻipū Road 7.6-acre Parcel	Inventory Survey
Hammatt et al. (Hammatt, Ida, Folk, Shideler, and Colin)	1993b	Poʻipū Beach Park	Subsurface Testing and Monitoring

NAME	YEAR	LOCATION	STUDY TYPE
Creed, Ida and Hammatt	1995	Poʻipū Road	Inventory Survey
Bushnell and Hammatt	1996	ʻŌmao Bridge, ʻŌmao Homestead	Archaeological Investigation
Hammatt, Creed, and Ida	1996	Waiohai Resort	Assessment Survey
McMahon	1996	Sheraton Kauaʻi Hotel	Reconnaissance Survey
Ida, Creed, and Hammatt	1997	Poʻipū Bypass Road	Inventory Survey
Hammatt et al.	1998	Kukuiʻula Planned Community Phase I	Data Recovery
Hammatt et al.	1999	Kukuiʻula Planned Community Phase II	Data Recovery
Yorck, Shideler, and Hammatt	2002	Kaumualiʻi Highway, Alexander and Baldwin Properties	Inventory Survey
Tulchin and Hammatt	2003	Eric Knudsen Trust Lands	Field inspection

> Our reconnaissance revealed that the most significant archaeological feature located within the study area is the extensive *ʻauwai* system. Remnants of this irrigation system were observed on both sides of Waikomo Stream . . . [This] network of watering canals proved to be the key to the success of the prehistoric Hawaiian Culture in turning these marginal lands into flourishing wet and dry agricultural fields. From information gathered from local informants and preliminary historical investigation of this area it is evident that the early commercial growers of sugar cane utilized the existing *ʻauwai* system. Gradually as more and more fields came under sugar cane production these replaced the wet and dry fields of an earlier day. Today the archaeological sites remaining stand as islands as these marginal cane lands were taken out of production and turned into pasture [Palama & Stauder 1973:4].

A survey by the ARCH in 1974 was conducted in the area encompassed by the sewage treatment plant to the west of the project area. A portion of a large agricultural complex was recorded. Ching, Palama, and Stauder conducted a surface survey for the ARCH of coastal lands (approximately 1000 acres) of the *ahupuaʻa* of Weliweli, Pāʻā, and Māhāʻulepū (Ching et al. 1974). Several important sites--specifically the Waiopili Heiau complex--were located, however extensive bulldozing and stone robbing had destroyed most of the surface features, making spatial analysis impossible.

Akihiko Sinoto conducted a reconnaissance survey of 400+ acres of Knudsen Trust Lands at Kōloa immediately to the west of the current project area. He recorded several features and suggested they were the northern remnants of Bennett's Sites 78, 79, 85 and 86. Sinoto located many sites with both habitation and agricultural features along the southern portion of the study area, from the sewage treatment plant to the Weliweli subdivision (Sinoto 1975).

In 1977, reconnaissance was undertaken to locate an *ʻauwai* that was reputed to run from Waikomo Stream to the area of the Prince Kuhio Hotel (Bordner 1977). A large *ʻauwai* was found, which corresponds to the major *ʻauwai* system assigned SIHP number 50-30-10-1934. A portion of an agricultural system to the north of the present study area was also described. In its lower section, the *ʻauwai* is built up into an aqueduct several feet above the surrounding ground surface; at present, this is a unique feature in the State of Hawaiʻi. Again, bulldozing and historic construction has damaged sections of the agricultural system, but there is no doubt that these sites are similar to those found in the study area.

In 1978, ARCH (Hammatt et al. 1978) conducted a survey of the Kiahuna area for Moana Corporation. A total of 460 acres of land was surveyed with extensive mapping and descriptive recording of a major complex of well-preserved nearly continuous and highly integrated agricultural and habitation features including long ʻ*auwai* originating from Waikomo Stream.

William Kikuchi (1979) conducted a reconnaissance survey north of Poʻipū Beach Road, north of the current project area in 1979. Kikuchi found agricultural features and concluded that the area lay within the coastal fringe part of the agricultural and habitation zone that extended inland all the way to Kōloa town. A tidal pool, a railroad berm, and several stonewalls were also recorded in the area.

Francis Ching (1983) conducted a reconnaissance survey, and an historical investigation of 230+ acres of Alexander and Baldwin lands within the *ahupuaʻa* of Kōloa (west Kōloa) and Lāwaʻi. According to Ching, three-fourths of the study area was bulldozed, with many rocks re-located, however, remnants of walls, *loʻi* (wetland cultivation), ʻ*auwai*, terraces, and an historic railroad berm were still discernable. These remnants are evidence of the great expanse of the Kōloa Field System.

James Landrum (1984), of the Bishop Museum, conducted a reconnaissance survey of a 200+ acre portion of Kukuiʻula. Landrum recognized that his survey area was once part of an extensive irrigated agricultural complex developed in the prehistoric period with superimposed historic-era occupation (Landrum 1984:24).

Hallett Hammatt, Douglas Borthwick, David Shideler, and Mark Stride (Hammatt et al. 1988) conducted an archaeological inventory survey in the 1000-acre proposed Kukuiʻula Bay Planned Community north and west of the current project area. Fifty-eight archaeological sites were recorded, many associated with the Kōloa Field System. Two to three *heiau* were found, including the remains of Kamaloula Heiau.

William Kikuchi (1988) conducted a reconnaissance level survey of the former Paʻanau Sugar Camp, inland and west of the present project area. The camp was located just *makai* of the present day Kōloa Elementary School. The survey recorded a number of cement foundations, ditches, and portable historic artifacts. Kikuchi states that archaeologically the site is interesting because it contains remnants of an early (1910-1950) plantation camp, even though the vast majority of its structures have been destroyed or removed.

Hallett Hammatt (1990) conducted an inventory survey of a 4.7-acre parcel at the west end of Paʻanau Road near Kōloa town, northwest of the present project area. The historical segment of this report indicates the previous existence of the Paʻanau Camp, and a railroad and ʻ*auwai* irrigation ditch which traversed the study area. However, the survey revealed the absence of any traces of pertinent features.

Hallett H. Hammatt (1991) carried out an archaeological reconnaissance for a proposed waterline stream crossing of Pōʻeleʻele Stream, north of Kōloa town, a significant distance to the northwest of the present project area. He noted extensive modern land modification and no significant findings.

Hallett H. Hammatt, William Folk, and Mark Stride (1991) conducted an archaeological inventory survey of 160 acres along the Kōloa-Weliweli Ahupuaʻa boundary. They located, mapped, described, and evaluated 75 sites and observed a wide range of site types. Their survey indicates that the Poʻipūlani project area was associated with the Kōloa Field System. This study is north of the current project area.

Hallett H. Hammatt (1992a) carried out an Archaeological Inventory Survey of a 3.8-acre property at Kīahuna, (TMK 2-8:014-026), but the entire parcel had been previously graded and there were no significant findings. This project is bounded by Poʻipū Road on the southeast and is northwest of the current project area.

Hallett H. Hammatt (1992b) carried out an Archaeological Reconnaissance of the Poʻipū Road and Lāwaʻi Road Junction near the mouth of Waikomo Stream, northwest of the current project area, but again there were no significant findings, owing to prior land disturbance.

Hallett Hammatt, Gerald Ida, William Folk, David Shideler and Brian Collin (Hammatt et al. 1993b) conducted an assessment survey, subsurface testing and monitoring at Poʻipū Beach Park in the *ahupuaʻa* of Kōloa, just south of the present project area. Wave action during Hurricane ʻIniki in 1992 had exposed a cultural layer (SIHP Site 50-30-10-745) which needed to be preserved and monitored during the reconstruction and restoration of the park. Auger testing (Hammatt et al. 1993b:11) revealed charcoal, and both traditional and historic midden and artifacts (i.e. basalt flakes and fragments, nails, glass, *kukui* shells, and mollusk shells). An historic cemetery (SIHP Site 50-30-10-1871), located in the middle of Poʻipū Beach Park, and other sections of the buried cultural layer beneath the park, were also monitored during the removal of several cement slabs, remnants of a pavilion, picnic tables, and barbecues. Three radiocarbon dates were determined for this layer: the earliest was A.D. 1282-1414 and latest ranged from A.D. 1678-1940 (*ibid*:52). The rich cultural layer, supported by radiocarbon dating, indicates that this shoreline occupation is contemporaneous with the development of the Kōloa Field System. This cultural layer is the "single largest coastal beach deposit in the *ahupuaʻa*...of Kōloa" (Hammatt et al. 1993b:65, 66) and greatly contributes to the information bank regarding the cultural development of the Kōloa district.

Victoria Creed, Gerald Ida and Hallett H. Hammatt (1995) reported on an inventory survey within a 1.4-mile corridor along the *mauka* side of Poʻipū Road (TMK 2-8-15, 16, 17 & 18) in the *ahupuaʻa* of Kōloa and Weliweli, north of the present project area. Three sites, including enclosures, a terrace, and the Kōloa-Weliweli boundary wall, survived previous bulldozing of the area and were understood as components of the Kōloa Field System.

Kristina Bushnell and Hallett H. Hammatt (1996) carried out an archaeological investigation of ʻŌmao Bridge in ʻŌmao Homestead, a significant distance northwest of the current project area. The only objects of historical interest noted were the existing bridge and features associated with an old railroad.

Hallett Hammatt, Victoria Creed, and Gerald Ida (1996) conducted an assessment survey of an exposed cultural layer in undisturbed sand deposits at Waiohai Hotel, west of the current project area. This layer was disturbed by high wave action during Hurricane ʻIniki, which completely destroyed the associated reconstructed Kihouna Heiau (SIHP Site 50-30-10-80). Three charcoal samples from this layer were dated to A.D. 1430-1950. The exposed cultural layer supports the potential existence of widespread intact cultural areas along the general shoreline (Hammatt et al. 1996:36, 39).

Nancy McMahon, (April 1996) at the time an independent archaeological consultant, completed a reconnaissance survey west of the current project area. The purpose of the survey of TMK 2-08-16:3 (8.444 acres), part of the Sheraton Kauaʻi Resort, was to report on damage caused by Hurricane ʻIniki. No surface sites or cultural deposits were reported. She noted a sandy deposit up to the foundations of the buildings on the eastern side of the project area near Lae o Kamilo. She suggested that the remnants of beach dunes could still exist and recommended monitoring of any construction in this area in case historic sites, including human burials, were uncovered.

Beginning in December of 1996, reconstruction of areas damaged by the hurricane began at the Sheraton Kauaʻi Hotel (McMahon 1996). Excavations took place to construct new buildings on new concrete pads. An intact cultural layer, designated Layer III was uncovered. The cultural layer, Layer III, was a dark sandy layer. After grading of one Pad area was complete, human skeletal remains were found in the excavated material. During monitoring of the rest of the project, a total of ten subsurface features (Features B-K) were discovered. Six were fire pits, one was a stain, one was a concentration of fire-cracked rocks, one was a C-shaped structure, and one was a pig skeleton. Eight burials were also uncovered within Layer III. Six charcoal samples were submitted for radiocarbon age determination for Layer III. These ranged from 20+/- 70 BP (before present) to 540+/- 60 BP, indicating that the earliest possible date for the features was A.D. 1400. The site was west of the current project area.

Gerald Ida, Victoria Creed and Hallett H. Hammatt (1997) conducted a reconnaissance survey on a 1.2 mile corridor of a proposed bypass road within the *ahupuaʻa* of Kōloa and Weliweli (TMK 2-8-02:3, 2-8-03:1, 2-8-04:1, 2-8-05:2) that had previously been bulldozed. This road extended from an existing bypass road at the coast to north of Kōloa town, north of the present project area. This survey did not reveal any archaeological sites, and further study was not recommended.

CSH (Hammatt et al. 1998) reported on data recovery of the Kukuiʻula Planned Community Project Phase One area encompassing approximately 219 acres. The project included excavations at 20 different sites, which encompassed 64 individual features. There were a total of 212 excavation units (212 m^2) and 19 backhoe trenches (only 14 backhoe trenches were chosen for study). Large quantities of midden (approx. 23.7 kg) and artifacts (10,635 items) were recovered and are reported on. The artifacts include a wide range of types with both indigenous (2,592 items) and historic (8,043 items) represented. Radiocarbon (C14) dates ranged from ca. A.D. 1050 onward. The earliest date came from the habitation/burial cave SIHP Site 50-30-10-1927A. In addition to the habitation sites and features dated, seven dating samples from agricultural features were also analyzed. The study is northwest of the present project area.

CSH (Hammatt et al. 1999) reported on data recovery work just *makai* and southwest of Kōloa Town on the west side of Waikomo Stream in the northeastern portion of the Kukuiʻula Planned Community Phase II Area. The study area is comprised of approximately 33 acres and has been used as a buffer zone between cane lands/pastures and the residential lots bordering

Poʻipū Road. While some ten land commission awards lie partially or entirely within the project area, most of these properties were bulldozed in the course of sugar cane cultivation. There were, however, areas that appeared undisturbed by sugar cane cultivation or heavy machinery. Excavations were conducted within five archaeological sites (13 features). These excavations yielded 264.8 g of midden; 53 indigenous artifacts (including 43 volcanic glass flakes, 9 basalt flakes, and one coral manuport); and 877 late-historic artifacts (e.g. glass, metal, ceramics, plastic, leather, and slate). Twelve charcoal samples were dated, and ranged from A.D. 1250-1410 to A.D. 1800 to present. This study lies northwest of the present project area.

Jesse Yorck, David Shideler, and Hallett Hammatt (2002) conducted an inventory survey of three proposed well sites near Pīwai Reservoir north of ʻŌmao Homesteads, located a significant distance northwest of the current project area. No archaeological sites were identified in the project area or vicinity.

In 2003, an archaeological survey was conducted along the coast in the Sheraton Kauaʻi Hotel property, west of the current project area (O'Hare et al. 2003). Saltpans, abraded areas, and possible bait cups were recorded along the rocky coast; these may correspond to Bennett's Site 76 "Salt pans, east of Waikomo Stream along the shore" (Bennett 1931:98). Five features were noted in the interior section of the project area, two platforms, one mound, one terraced area, and one enclosure. The two platforms were later partially dismantled to test for burials. No human remains or any other cultural materials were recovered from the features.

B. Summary of Previous Archaeology Specific to Current Project Area

Archaeological sites in the project area were originally located and described as part of the archaeological survey in support of the proposed Kiahuna Golf Village project by the Archaeological Research Center Hawaiʻi (ARCH) (Hammatt et al. 1978) (Figure 5). An archaeological report was completed; however its status with the State Historic Preservation Division (SHPD) as an accepted inventory survey report is unclear. A total of 583 features were recorded in a total surveyed area of 460 acres. The current project area was covered as the *makai* (southern) portion of the Kiahuna survey area designated Area C. Sites were located and described with no subsurface testing. Both habitation and agricultural sites were located in the current project area, including stone enclosures, platforms, *ʻauwai* (irrigation ditches), and terraced plots. Selective preservation or data recovery was recommended for sites in the Kiahuna Golf Village project area as "they represent a highly significant cultural resource of substantial value for archaeological research and interpretation" (Hammatt et al. 1978).

The eastern portion of the current project area was resurveyed by CSH as part of the archaeological survey for the proposed Kōloa-Poʻipū Bypass Road project (Hammatt et al. 1985) (Figure 5). Archaeological work was completed, however the plans for the road alignment were abandoned and a completed survey report was never submitted to SHPD. A total of 47 previously identified and undocumented sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt et al. (1978). Ten sites, including enclosures and C-shaped structures, were selected for subsurface testing, eight of which are in the current project area. "The testing showed only sparse evidence of occupation with no apparent cultural stratification" (Hammatt et al. 1985:i). The best examples of sites were recommended for either preservation or data recovery.

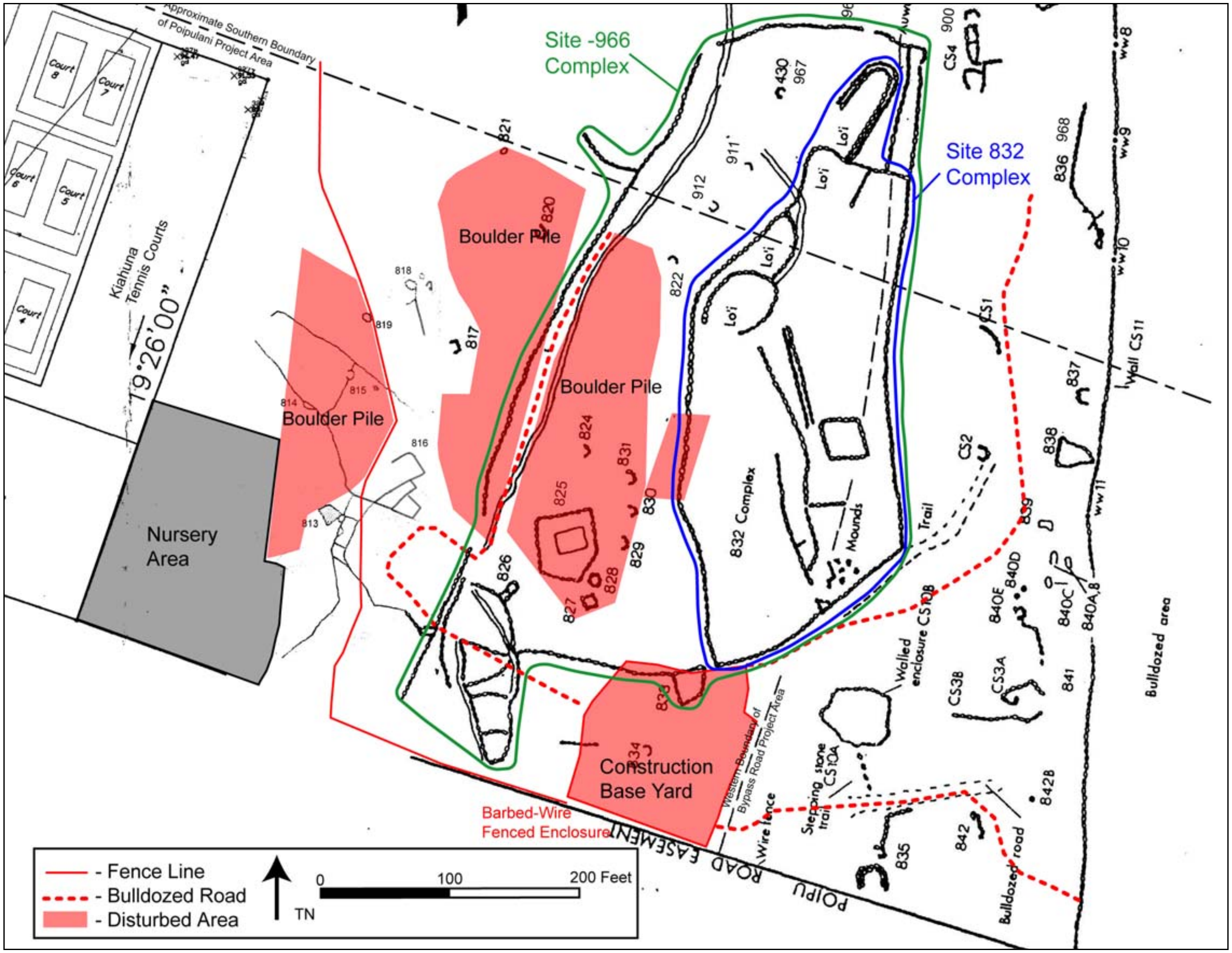


Figure 5. Portions of Kiahuna Golf Village (Hammatt et al. 1978) and Kōloa-Po‘ipū Bypass Road (Hammatt et al. 1985) archaeological site maps, and Kodani & Associates survey map showing previously recorded archaeological sites (some of which are no longer intact) and disturbed areas in the project area

The area immediately *mauka* (north) of the current project area was resurveyed as part of the archaeological inventory survey in support of the proposed Poʻipūlani Golf Course project (Hammatt et al. 1991). This report was reviewed and accepted by SHPD along with a data recovery and preservation plan for the property (Hammatt 1991). A total of 75 sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt et al. (1978). Sites previously identified in the Kiahuna Golf Village and Kōloa-Poʻipū Bypass Road projects were relocated and assigned state site numbers. Preservation was recommended for "major sites," and "all other sites which cannot be incorporated into the development should be subjected to a program of data recovery including subsurface testing and excavation" (Hammatt et al. 1991:i). The Poʻipūlani Golf Course inventory survey did not cover any portions of the current project area, though descriptions and recommendations were made concerning SIHP Site 50-30-10-966 (complex), which extends into the current project area.

In 2003, Tulchin and Hammatt inspected the current project area. Pedestrian inspection of the project area was accomplished by following along the borders of disturbed areas including large boulder piles, fenced enclosures, and bulldozed roads using GPS. Existing sites in the vicinity of the various disturbed areas were located and their condition assessed. Sites within the interior of the GPS surveyed boundaries of disturbed areas had either been covered or destroyed. The collected GPS data was overlain on archaeological site maps associated with the Kiahuna Golf Village project (Hammatt et al. 1978) and the Kōloa-Poʻipū Bypass Road project (Hammatt et al. 1985) (see Figure 5). Table 2 contains a summary of all sites/features previously identified in the project area, including recommended treatment provided in earlier studies, and the status of these as determined in the 2003 study (see Tulchin and Hammatt 2003).

During the 2003 inspection, in the *makai* (southern) portion of the project area, a barbed wire fenced enclosure (possibly a corral for cattle) was observed (see Figure 5). The interior of the fenced enclosure was grubbed and sites 833 (enclosure) and 834 (C-shaped structure) were presumably destroyed in the process. No recommended treatment had been specified for sites 833 and 834.

In the central portion of the project area, two piles of large basalt boulders were observed. The two piles were approximately 3-5 m in height and were separated by a bulldozed road. The eastern boulder pile had been placed over features 824 (C-shaped structure), 825 (platform), 827 (enclosure), 828 (enclosure), 829 (C-shaped structure), 830 (enclosure), and 831 (C-shaped structure), which were presumed destroyed in the process. A portion of the interior stone wall of State Inventory of Historic Places (SIHP) SIHP Site 50-30-10-966 (ARCH site 832; complex) was also disturbed by bulldozing activities in the area. Each of these eight features are components of the SIHP Site -966 agricultural/habitation complex. SIHP Site -966 is described as a field system containing "prehistoric field walls in the interior but was modified in historic times with the addition of a surrounding cattle wall which encloses the fields" (Hammatt et al. 1991:110). A portion of the *ʻauwai* that runs along the western edge of SIHP Site -966 is also assumed to have been destroyed. Preservation with interpretation had been recommended for SIHP Site -966, including all features within the surrounding stone wall, based on criteria C and D of the National and State Registers of Historic Properties (Hammatt et al. 1991; Hammatt 1991).

The western boulder pile in the central portion of the project area had been placed over sites 820 (C-shaped structure), 821 (enclosure), and a portion of the perimeter wall of SIHP -966 (complex) (see Figure 5). These sites were presumably destroyed in the process. No recommended treatment had been specified for sites 820 and 821.

In 2003, the western portion of the project area was being utilized as a base yard for a landscaping (nursery) operation (see Figure 5). A barbed-wire fence separates the nursery from the cattle grazing lands. The cleared nursery areas generally abut the fence line. Site 813 (platform & associated C-shaped structures), while located in the nursery lands, was spared from the bulldozing activities. Sites 814 (enclosure), 815 (C-shaped structure), and 819 (enclosure) were located within the nursery's operational area and are presumably destroyed. No recommended treatment had been specified for these sites and, although the site area has been compromised, site 813 was found to be in good condition and is likely to have significant archaeological research value.

The bulldozed access road that runs between the two large boulder piles *makai* (south) of the fenced enclosure, passed through the *makai* (southern) portions of SIHP -966 (complex). The disturbed area was previously described as a "series of wet agricultural fields descending in five terraces to the south, and fed directly by an *'auwai* entering the system from the north" (Hammatt et al. 1978:82). Bulldozed access roads were also observed in the eastern portion of the project area, though no sites appeared to be impacted.

IV. PREDICTIVE MODEL

The information gathered from legendary inferences, traditional accounts and recent history of Kōloa Ahupuaʻa provide a good background to produce a predictive model for this project area. The legends indicated the existence and importance of water in Kōloa. The myths also indicated Maʻulili Pool in Waikomo Stream as a traditional cultural significant place in Kōloa area and associated with irrigated agriculture or field system.

From pervious archaeological studies and historic accounts it appears that habitation and intensive irrigated agriculture were widespread in central and coastal Kōloa utilizing the opportunity to develop an extensive irrigated complex (the Kōloa Field System) off of Waikomo Stream. As the Judd (1935) account asserts, it is likely that low inland areas were used for less intensive cultivation patches of sweet potato, *pia*, and *wauke* and the gathering of *hala, kukui* and other resources. The coastal portion would be a focus for permanent habitation, collection of marine resources, ceremonial activities, and burials.

Kōloa Ahupuaʻa was also described by early archaeologists as both "in a high state of cultivation" and the evidence of field systems (*loi*) and irrigation channels (*auwai*) have been found throughout the sections of Kōloa. The project area is located approximately 400 m inland from the coast and it is likely that both habitation and agricultural features would be present there.

There have been numerous archaeological studies conducted in Kōloa Ahupuaʻa however, five of these studies are in close proximity and adjacent to the subject property and will be discussed. Hammatt (1992a) conducted an inventory survey on a 3.8 acre parcel and noted no significant findings due to this parcel had been previously graded. Hammatt et al. (1993a) carried out an inventory survey and identified two previously recorded sites (Old Railroad Grade, and SIHP Site 3758 a house platform or possible *heiau)* and three new sites (habitation and agricultural complexes). These sites are remnants of traditional *auwai*, walls, fields, enclosures and habitation platforms. These two areas were situated approximately 200 m west of the subject parcel. An archaeological assessment (Tulchin and Hammatt 2003) was conducted on the current project area, locating 34 archaeological sites. During the assessment, it was noted that many sites had been modified by rock collectors and that several of the sites were covered in boulder piles (see Figure 5). These sites were assumed to have been destroyed.

Hammatt et al. (1978) conducted a survey in the Kiahuna lands area and identified 583 archaeological sites including 175 enclosures, 108 house platforms, *ʻauwai,* fields, terrace plots, and rock mounds. The current project area was designated "Area C" in which 27 sites were recorded. In 1985, Hammatt et al. conducted an archaeological inventory survey at the same area of the Kōloa-Poʻipū Bypass Road. The survey with subsurface testing identified a total of 47 archaeological features. These findings were consistent with what have been recorded by Hammatt et al. (1978).

In 2003, Tulchin and Hammatt inspected the current project area. Sites within the interior of the GPS surveyed boundaries, labeled "Disturbed Area", had either been covered or destroyed.

In the central portion of the project area, two piles of large basalt boulders were observed. The two piles were approximately 3-5 m in height and were separated by a bulldozed road. The eastern boulder pile had been placed over features 824 (C-shaped structure), 825 (platform), 827 (enclosure), 828 (enclosure), 829 (C-shaped structure), 830 (enclosure), and 831 (C-shaped structure), which were presumed destroyed in the process. A portion of the interior stone wall of SIHP Site 50-30-10-966 (ARCH site 832; complex) was also disturbed by bulldozing activities in the area. Each of these eight features are components of the SIHP Site -966 agricultural/habitation complex.

The western boulder pile in the central portion of the project area had been placed over ARCH sites 820 (C-shaped structure), 821 (enclosure), and a portion of the perimeter wall of SIHP -966 (complex) (see Figure 5). These sites were presumably destroyed in the process.

Thus, although a broad range of site types is known to have existed within and in the general vicinity of the current project area, many sites had been modified and/or destroyed by rock collecting and bulldozing activities (see Figure 5).

V. RESULTS OF FIELDWORK

A. Impacts to No Longer Existing Sites

During the 2003 archaeological assessment of the parcel (Tulchin and Hammatt, 2003) it was observed that the known locations of several previously documented archaeological sites were covered by large boulder piles, including ARCH Sites 814, 815, 819-821, 824, 825, 827-831, 834, 838, and portions of SIHP Site 50-30-10-966 (see Figure 5, Table 2). The boulder stockpiles had been created sometime after 1985. The total impact to these previously identified sites was unclear at the time of assessment.

Archaeological monitoring was conducted by CSH, at the request of SHPD/DLNR Kaua‘i Archaeologist Nancy McMahon during the removal the boulder stockpiles. Work began on Oct. 12, 2004 and was completed on Nov. 8, 2004.

During the course of monitoring, none of the sites in question were encountered, as the sites were bulldozed prior to the creation of the stockpiles (see Figure 5). Boulders in the stockpile still had a red patina, indicating that the piling activities were taking place until very recently. Thus, based on observations during archaeological monitoring, ARCH Sites 814, 815, 819-821, 824, 825, 827-831, 834, including associated subsurface deposits, no longer exist due to the bulldozing and boulder stockpiling activities.

In addition to the twelve sites completely destroyed by bulldozing and boulder stockpiling activities, six additional sites [SIHP Site -3786 (ARCH 833), -3788 (ARCH 835), -3792 (ARCH 839), -3793 (ARCH 840), ARCH 841, and -3795 (ARCH 842)] were not located during the present study. It is presumed that these sites were destroyed during previous road construction, which occurred prior to the present study.

B. Research Design

Of the 33 sites known to have existed in the project area, 18 have been destroyed. Eight of the sites and features had been previously tested (Hammatt et al. 1985). Field inspections were made of these sites to determine significance but they were not tested again.

This leaves 16 intact sites or features previously untested: 9 associated with C-Shapes, 5 with enclosures, 3 with platforms, 5 with walls, 2 with storage features, one with a trail, and one complex of features (site -966) that also includes agricultural terraces, mounds, and an *‘auwai* (Table 3). During the inventory survey, a sample of features was selected for subsurface testing through hand excavation. The selections were made based on the state of preservation of the feature, the potential for yielding information, testing a representative sample of site and feature types, as well as by function.

Testing in other areas of Kōloa has indicated that few, if any, burials are located in surface structures; rather lava tubes and sand dunes have been documented as locales of choice. However the testing of platforms, mounds, and terraces, while addressing presumed habitation and agricultural functions, also served to test for burials. Six units were excavated within the project area. Subsurface testing focused on C-shapes, enclosures, platforms, and mound and terrace features. Two units were placed in C-shaped structures, one in an enclosure, one in a platform, and two in agricultural terraces.

Table 2. Previously Documented Sites Destroyed Prior to or Unlocated During the Inventory Survey

ARCH Site	SIHP Site # 50-30-10-	CSH Site #	Type	Function	Previous Work Done			Present State (2004)	Recommendations (Significance)
					Kiahuna (1978)	Kōloa-Po‘ipū Bypass Road (1985)	Po‘ipūlani (1991)		
814			Enclosure	Habitation	located & described			Destroyed, (in nursery)	No longer significant
815	3768		C-shape	Habitation	located & described			Destroyed, (in nursery)	No longer significant
819			Enclosure	Habitation	located & described			Destroyed, (in nursery)	No longer significant
820			C-shape	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
821			Enclosure	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
824			C-shape	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
825			Platform	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
827			Enclosure	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
828			Enclosure	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
829			C-shape	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
830			Enclosure	Habitation	located & described			Destroyed, (boulder pile)	No longer significant
831			C-shape	Habitation	located & described			Destroyed, (boulder pile)	No longer significant

ARCH Site	SIHP Site # 50-30-10-	CSH Site #	Type	Function	Previous Work Done			Present State (2004)	Recommendations (Significance)
					Kiahuna (1978)	Kōloa-Po‘ipū Bypass Road (1985)	Po‘ipūlani (1991)		
833	3786		Enclosure	Habitation	located & described			Destroyed, (construction base yard)	No longer significant
834			C-shape	Habitation	located & described			Destroyed, (construction base yard)	No longer significant
835	3788		C-shape	Habitation	located & described	located & described		Destroyed by rock collecting	No longer significant
839	3792		Enclosure & assoc. c-shaped structure	Habitation	located & described	located & described		Destroyed by rock collecting and bulldozing	No longer significant
840	3793		Complex		located	located, described, & tested		Destroyed by rock collecting and bulldozing	No longer significant
841			Mound					Destroyed by rock collecting	No longer significant
842	3795 A		Wall & 2 c-shaped shelters	Habitation	located & described	located, described, & tested		Destroyed by bulldozing	No longer significant

C. Site Descriptions

A total 16 sites were identified in the project area. Each site and individual component feature was documented during the inventory survey, including descriptions of the formal site/feature type, metric dimensions, quantity, function, presence of cultural material, potential for subsurface cultural deposits and previous site numbers. Site type was designated based on physical attributes of the features within the site while site function was based on perceived use of the collective features within the site. Figure 6 shows an overall project map with all of the plotted sites within the project area. Table 3 below, lists all sites with columns for SIHP Site, previous ARCH site number, type, function, description of previous work done, and current condition.

Table 3. Sites Relocated During Present Inventory Survey

SIHP Site # 50-30-10-	**Previous ARCH or CSH Site #**	**Type**	**Function**	**Archaeological Work Accomplished**				**Condition (2004)**	**Recommendations (Significance)**
				Kiahuna (1978)	**Kōloa-Po'ipū Bypass Road (1985)**	**Po'ipūlani (1991)**	**Current study**		
966	ARCH 832	Complex	Agriculture and habitation	Located & described	Located & described as -832 complex	Located & described	Located & described	Remnant	Preserve remnant (C, D)
3766	ARCH 813	Wall, C-shapes and Mound	Habitation	Located & described			Located, described, & tested	Remnant	Data recovery (D)
3769	ARCH 816	Walls, Terrace, Enclosure and Mound	Habitation	Located & described			Located & described	Remnant	Data recovery (D)
3770	ARCH 817	C-shape	Habitation	Located & described			Located, described,	Remnant	Data recovery (D)

SIHP Site # 50-30-10-	Previous ARCH or CSH Site #	Type	Function	Archaeological Work Accomplished				Condition (2004)	Recommendations (Significance)
				Kiahuna (1978)	Kōloa-Po‘ipū Bypass Road (1985)	Po‘ipūlani (1991)	Current study		
							& tested		
3771	ARCH 818	Mound	Habitation	Located & described			Located & described	Remnant	No further work (D)
3775	ARCH 822	C-shape	Habitation	Located & described			Located & described	Remnant	No further work (D)
3779	ARCH 826	Enclosure	Storage	Located & described			Located & described	Remnant	No further work (D)
3785	ARCH 832	Large complex of features	Agriculture	Located & described	Located & described	Located & described, included in -966 complex	Located, described, & tested	Partially destroyed remnant	Data recovery (D)
3790	ARCH 837	C-shape	Habitation	Located & described	Located, described, & tested		Located & described	Intact	Data recovery (D)
3791	ARCH 838	Enclosure	Habitation	Located & described	Located, described, & tested		Located, described, & tested	Partially disturbed	Data recovery (D)
3896	CSH 1	Wall	Agriculture		Located & described		Located & described	Remnant	No further work (D)
3897	CSH 2	C-shape	Habitation		Located & described		Located & described	Remnant	Data recovery (D)
3898	CSH 3	Mound	Habitation	Located	Located & described		Located & described	Remnant	No further work (D)

SIHP Site # 50-30-10-	Previous ARCH or CSH Site #	Type	Function	Archaeological Work Accomplished				Condition (2004)	Recommendations (Significance)
				Kiahuna (1978)	Kōloa-Poʻipū Bypass Road (1985)	Poʻipūlani (1991)	Current study		
3899	CSH 10B	Enclosure	Agriculture		Located & described		Located & described	Remnant	Data recovery (D)
3900	CSH 11	Wall	Probable *ahupuaʻa* boundary	Located	Located & described		Located & described	Mostly intact	Preserve (C, D)
3905	New site	C-shapes and terrace	Habitation				Located, described, & tested	Mostly intact	Data recovery (D)

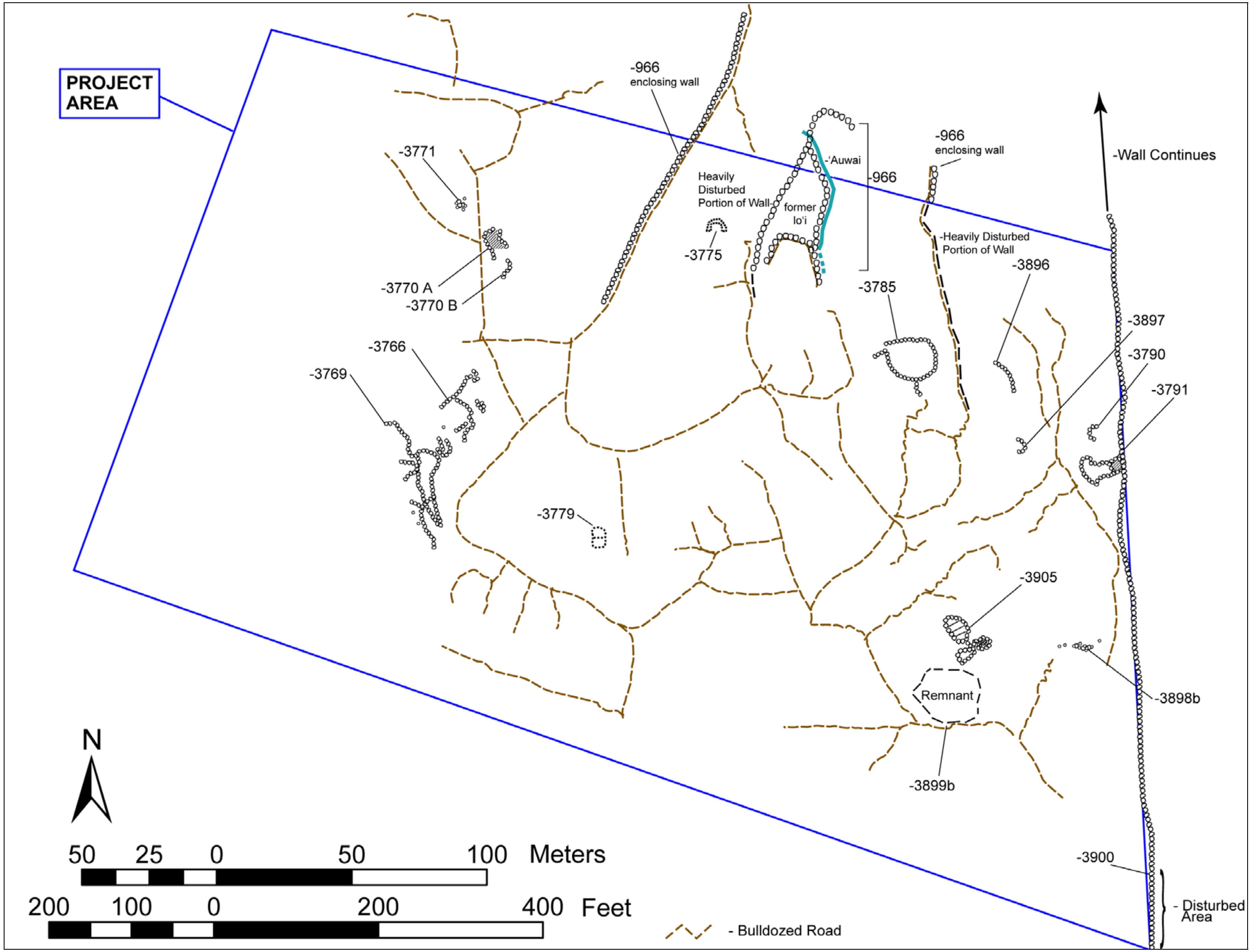


Figure 6. Map of remaining sites within project area, locations recorded using Trimble GPS unit

SIHP SITE **50-30-10-966**

FUNCTION: Habitation and Agriculture

SITE TYPE: Complex

TOTAL FEATURES: Two Features and One Complex Remaining

DIMENSIONS: 75 m by 1.25 m

DESCRIPTION: Approximately one third of this complex lies outside of the project area to the north. The -966 complex includes the previous ARCH 832 complex. This site has been heavily impacted by modern rock collecting and bulldozing within the project area. Only portions of this complex remain intact within the project area, and are located near the northern boundary of the project area. Portions of the complex that are located outside (*mauka*) of the project area (to the north) are still intact.

Within the project area, near the northern boundary, approximately 75 meters of the western stone wall that encloses the complex is still relatively intact, although it has been moderately impacted by rock collecting. The southern section of the complex enclosure wall has been obliterated by a bulldozed road.

Within the project area, near the northern boundary, a *lo'i* wall and an adjacent *'auwai* (that runs along the eastern side of the wall) have been somewhat impacted by a bulldozed road and are not continuously traceable (see Figure 6). The southern section of the wall has been obliterated by a bulldozed road. The enclosed agricultural fields and miscellaneous walls in the southwest corner of the complex have been all but destyroed by rock collection. Only a few discontinuous amalgamations of basalt cobbles are left.

SIHP SITE **50-30-10-3766**

FUNCTION: Habitation

SITE TYPE: Wall, C-Shapes and Mound

TOTAL FEATURES: 6

DIMENSIONS: 51.3 m by 24.9 m

DESCRIPTION: Site -3766 is an interconnected complex of stacked walls, C-Shapes and a mound. Feature A is a wall measuring 18.8 m by 2 m; it is stacked two tiers high and is constructed of medium to large basalt boulders. Feature B is a C-shape measuring 4.7 m by 4.3 m, stacked two tiers high and constructed of small to large basalt boulders. Feature C is a C-shape measuring 12 m by 7 m; the feature is stacked with 3 tiers of basalt cobbles to boulders. Feature D is a mound constructed of small to large basalt boulders. It measures 3.5 m by 3 m The site is in fair to good condition. (Figure 7)

SIHP SITE **50-30-10-3769**

FUNCTION: Habitation

SITE TYPE: Walls, Terrace, Enclosure and Mound

TOTAL FEATURES: 4

DIMENSIONS: 28.4 m by 20.5 m

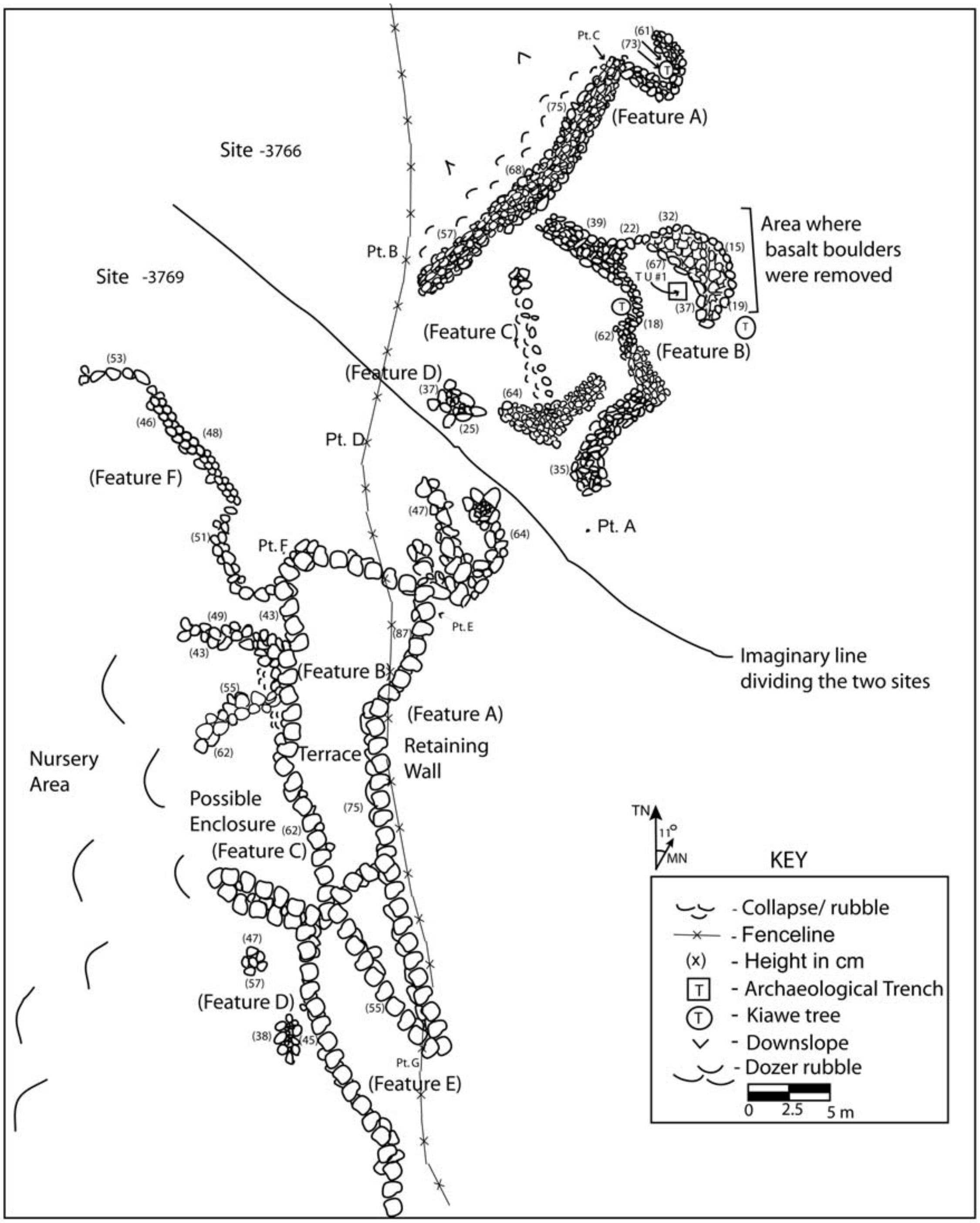


Figure 7. Plan View of SIHP Site 50-30-10-3766 and -3769

DESCRIPTION: SIHP Site 50-30-10-3769 is a habitiation complex that consists of: (Feature A) a retaining wall, (Feature B) terrace, (Feature C) an enclosure (Feature D) a mound and (Features D & F) walls. Feture A is a retaining wall. The retaining wall measures 35.7 meters in length and 0.7 meters in thickness. It is constructed of small to large basalt boulders stacked two to five courses high to a maximum height of 0.87 meters. East of the retaining wall is a level area which consists of soil and vegetation. There is a 31.0 by 8.0 meter terrace that abutts the west end of the retaining wall (Feature B). The retaining wall of the terrace is constructed of small to large basalt boulders stacked two to four courses high to a maximum height of 62 cm. The interior surface of the terrace is level and consists of soil and vegetation. At the west end of the terrace are four walls (Features E and F).

The walls vary from 18.3 to 6.7 meters in length and 0.5 to 1.8 meters in thickness. All the walls are constructed of small to large basalt boulders stacked one to four courses high. These walls might have been part of a structure at one time, but due to the bulldozed area on the west side of the complex in the Kaua‘i Nursery area, its not discernable. There is a 3.7 meter by 1.7 meter oval-shaped mound at the south western end of this complex, and it's constructed of small to large boulders stacked one to three courses high with a maximum height of 0.45 meters. Small basalt cobbles are used to fill in the spaces of the boulders. The site is in fair condition (see Figure 7).

A single excavation, Test Unit 1, was completed at Site -3769. 119.4 g of midden was recovered, reflecting habitation occupation of the site.

SIHP SITE **50-30-10-3770**

FUNCTION: Habitation

SITE TYPE: C-Shape, Modified Outcrop Terrace

TOTAL FEATURES: 2

DIMENSIONS: (Feature A) 6 m by 6 m, (Feature B) 8 m by 9 m

DESCRIPTION: Feature A is a C-shape that has been reduced to a remnant by rock collecting. Nearly the entire wall that forms the site has been removed. Remnants remaining consist of two small piles of basalt cobbles, apparently former wall fill, and a few boulders which mark the two ends of the C-shape wall. A bulldozed road passes adjacent to the site on the SW side, apparently used for access by the rock collectors. Even though this site is only a remnant, test excavation potential remains good. Strategic location of any future excavations is still possible as the footprint of the former structure remains fairly discernable. No cultural material was observed.

Feature B is a possible habitation complex that consists of a modified outcrop and a terrace (Figure 8). The 4.7 by 3.7 meter modified crop is constituted of small to large basalt cobbles stacked one to three courses high between the spaces of the natural bedrock boulder outcrop. The maximum height of the modified outcrop is 0.75 meters. The modification that was done to this outcrop was similar to that of a terrace or a retaining wall. The interior surface of this "terrace-like" outcrop is level and consists of loose soil and vegetation. The modified outcrop abutts the west and south face of a large bedrock boulder outcrop. Just west of the modified outcrop is a 8.0 by 7.4 meter terrace. The retaining wall of the terrace is constructed of "mound-like" structures that most likely connected at one time. The "mound-like" structures in the retaining walls are constructed of small to large basalt boulders and cobbles stacked ont to three courses high to a maximum height of 0.62 meters. The interior surface is level and consists of loose soil, a few large basalt boulders and vegetation. There are several roads to the west of the terrace that most likely contributed to the damage to the structure. The site is in fair to poor condition (Figures 8-10).

Two test units, Test Unit 2 and 3, were completed at Site -3770.Two volcanic glass flakes were recovered from Test Unit 2 (-3770 A), and 54.1 g of midden was recovered from Test Unit 3 (-3770 B).

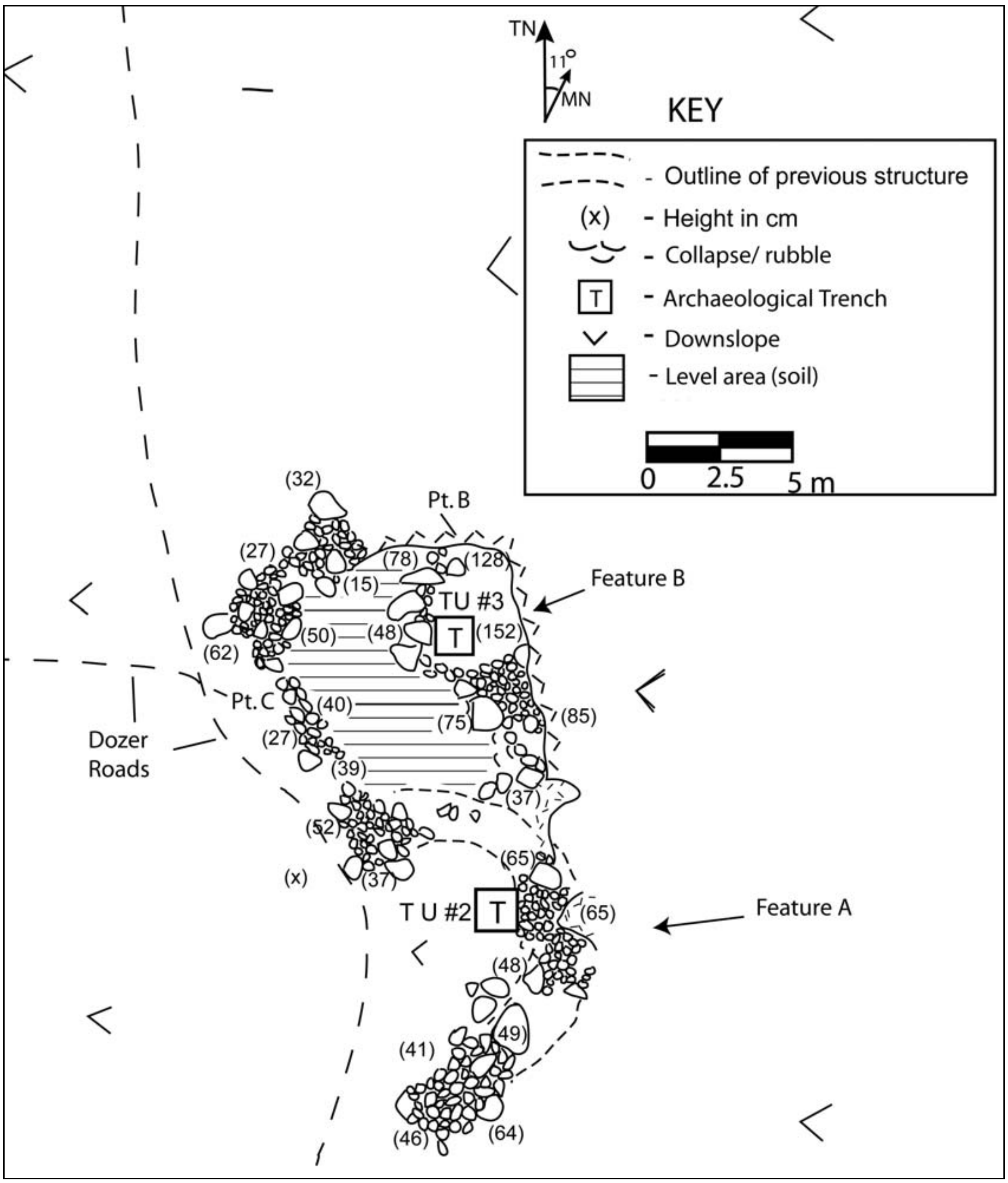


Figure 8. Plan View of SIHP Site 50-30-10-3770

Figure 9. SIHP Site 50-30-10-3770, remnant of Feature A, view north

Figure 10. SIHP Site 50-30-10-3770, remnant of Feature B, view east

SIHP SITE **50-30-10-3771**

FUNCTION: Habitation (Remnant)

SITE TYPE: Former C-shape

TOTAL FEATURES: 1 (Remaining)

DIMENSIONS: 2 m by 3 m

DESCRIPTION: Site -3771 was formerly a C-shape (Hammatt et al. 1978). This site has been essentially destroyed by a bulldozed road, which passes near the SW side of SIHP Site 3770 (ARCH 817). All that remains of this site is a small amorphous amalgamation of basalt cobbles with a few boulders. It is impossible to determine what portion of the site this represents. No cultural material was observed. The excavation potential of this site is poor, as strategic placement of excavation trenches is difficult. Original site decriptions and measurements aree found in 1978 Kiahuna Golf Village Area Report.

SIHP SITE **50-30-10-3775**

FUNCTION: Habitation (Remnant)

SITE TYPE: C-shape

TOTAL FEATURES: 1 (Remaining)

DIMENSIONS: 2.m by 2.75 m

DESCRIPTION: This C-shape has been reduced to a remnant by rock collecting (see Figure 6). Essentially all of the boulders have been removed from the structure leaving a linear mound of cobbles in the shape of a "C." The footprint of the structure is still discernable, so excavation potential is good. The western edge of the structure is less than 1 m away from the eastern boulder stockpile in the project area.

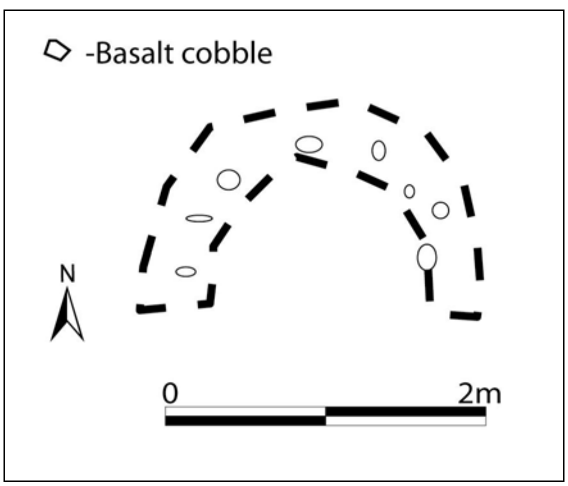


Figure 11. SIHP Site 50-30-10-3775, remnant of C-Shape, view west

SIHP SITE **50-30-10-3779**

FUNCTION: Storage

SITE TYPE: Enclosures

TOTAL FEATURES: 2

DIMENSIONS: 60 m

DESCRIPTION: This site once consisted of two small, abutting circular enclosures (see Figure 6). Rock collecting activity has reduced it to a pile of rubble made up mostly of basalt cobbles and large boulders. The once enclosed areas are no longer discernable. No cultural material was observed. Excavation potential is poor to none because strategic placement of trenches is now impossible.

SIHP SITE **50-30-10-3785**

FUNCTION: Agriculture

SITE TYPE: Complex

TOTAL FEATURES: 1

DIMENSIONS: 60 m

DESCRIPTION: Only a small remnant (approximately 60 meters long) of the stone wall that encloses most of the -3785 enclosure remains on the west side near the north boundary of the project area. The rest of the enclosing wall has been bulldozed and subject to rock collecting, including the west, south, and east sections, although the wall is fairly intact north of the project area. Interior wall and mound features at the southern end of the complex have been cleared by bulldozing. The enclosure has been reduced to a structural remnant by rock collection. Almost all of the structural boulders have been removed leaving a linear mound of cobbles that denote the orginal footprint of the enclosure. Shell midden was observed including cypreaea. The walls to the west of the enclosure have been reduced to remnants by rock collection as has the semi-circular loi wall. The site has been heavily impacted by rock collecting and is in poor to remnant condition. The enclosure was remapped (Figures 12, 13)

A single excavation, Test Unit 4, was completed at Site -3785. No material culture was recovered.

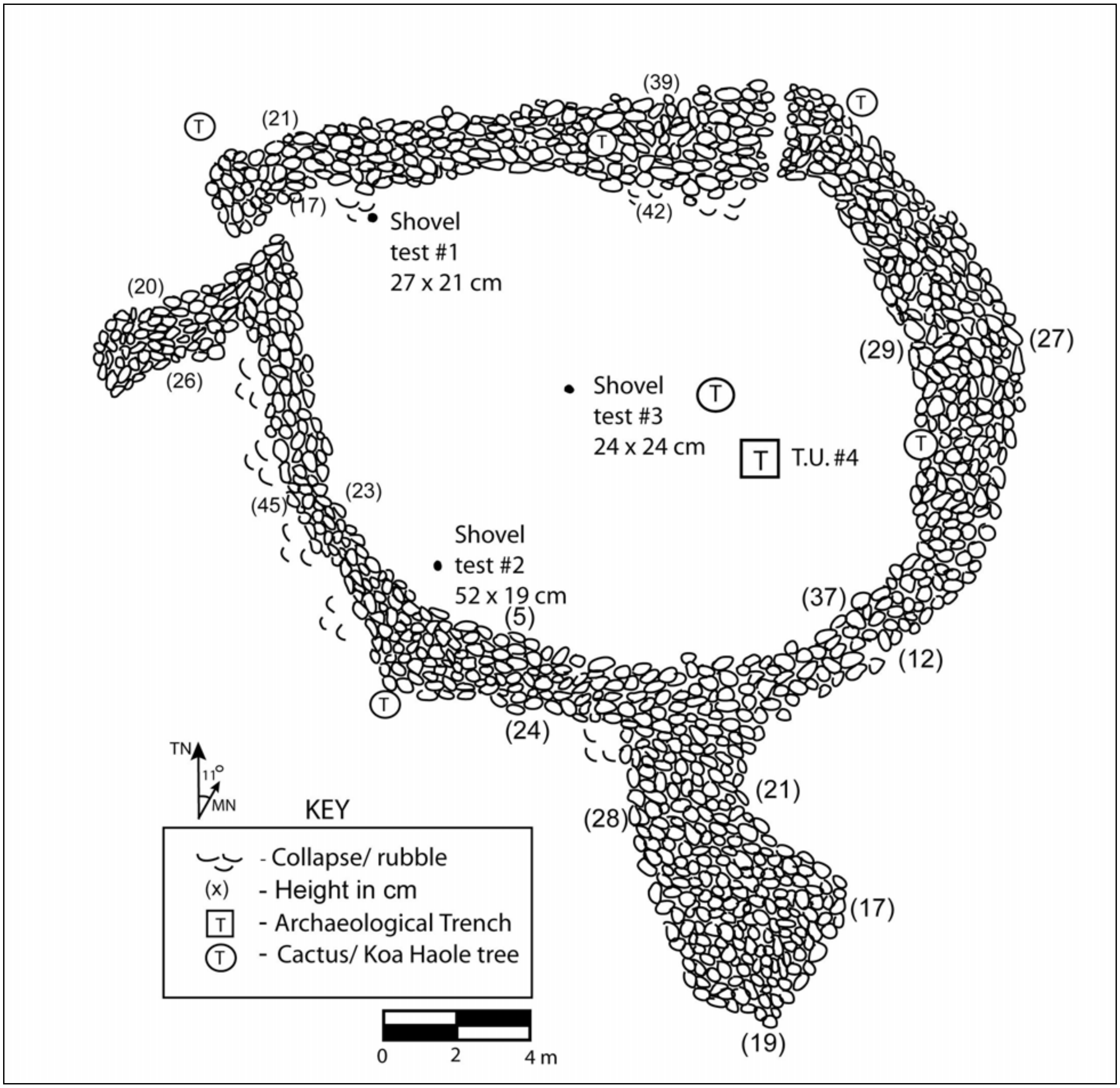


Figure 12. Plan View of SIHP Site 50-30-10-3785

Figure 13. SIHP Site 50-30-10-3785, Portion of *lo'i* wall, view north

SIHP SITE **50-30-10-3790**

FUNCTION: Habitation

SITE TYPE: C-Shape

TOTAL FEATURES: 1

DIMENSIONS: 7.6 m by 8.2 m

DESCRIPTION: SIHP Site 50-30-10-3790 has been impacted by rock collecting. The enclosure wall is still visible but is lower in height than when it was recorded in 1985. This site was tested in 1985 for the proposed Kōloa Bypass Road. The maximum original wall height measure 46cm high, though one area appears to be elevated further by a kiawe root at the base of the wall (Figure 14). The structure is roughly oval, measuring about 7.6m by 8.2m with collapse along the eastern portion of the enclosure. The interior consists of exposed bedrock with soil pockets. Test Unit 1 was excavated over a soil pocket within the southeastern portion of the enclosure. Site -3790 is in fair condition. (Figures 14, 15)

Subsurface testing results for TU 1, -3790 (ARCH 837) are from the 1985 Po‘ipū bypass report. The included description is as follows: “Test Unit1, a one-square meter unit; was excavated to a maximum depth of 13 cm (average depth 8 cm) to pahoehoe bedrock. There was approxomatly one gram of marine shell midden and one volcanic glass flake fragment recovered.” (Hammatt et al. 1985:42)

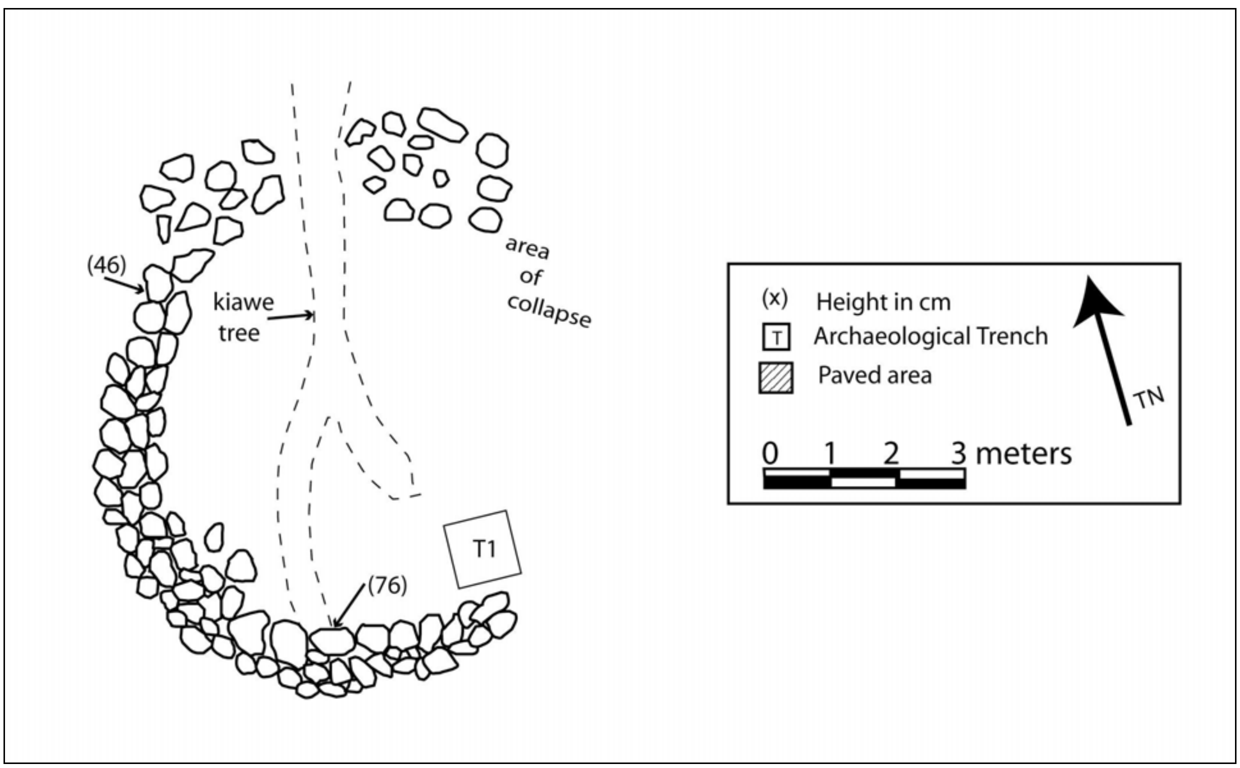


Figure 14. Plan View of SIHP Site 50-30-10-3790

Figure 15. SIHP Site 50-30-10-3790, remnant of C-Shape structure, view southeast

SIHP SITE **50-30-10-3791**

FUNCTION: Habitation

SITE TYPE: Enclosure and Platform

TOTAL FEATURES: 2

DIMENSIONS: Feature A: 12.2 m by 7.9, Feature B: 5.5 m by 5.7 m

DESCRIPTION: Feature A is an enclosure has been impacted by rock collecting. Parts of the west wall are gone. The enclosure was tested with 3 test units in 1985 (Hammatt et al. 1985).

Feature B is a slightly raised platform which is paved with basalt cobbles and pebbles. The feature, measuring 5.5 x 5.7 m, was newly documented during the present survey. The feature is in good condition and a waterworn basalt hammerstone was observed on the surface. An additional test unit (Test Unit 5) was excavated in this portion of site -3791 during the present inventory survey. Midden totaling 31.8 grams was recovered from the excavation. Excavation potential of this area is good even though deposits may be relatively shallow. The site is in fair condition. (Figures 16, 17)

Subsurface testing results for TU 1, 2 and 3, -3790 (ARCH 838) are from the 1985 Poʻipū bypass report. The included description is as follows: "Test Unit 1, a one-square meter unit, was excavated in the northwest portion of the enclosure. It revealed a maximum of 25 cm of soil overlying sterile subsoil and bedrock. There were about 20 grams of midden, mostly marine shell midden, and a single volcanic glass flake….Test Units 2 and 3, .50 m by .50 m units, did not contain any midden or artifacts. Sterile subsoil (C-horizon) and pahoehoe bedrock were reached at depths ranging from 15-35 cm below surface with average depth being around 20 cm." (Hammatt et al. 1985:39)

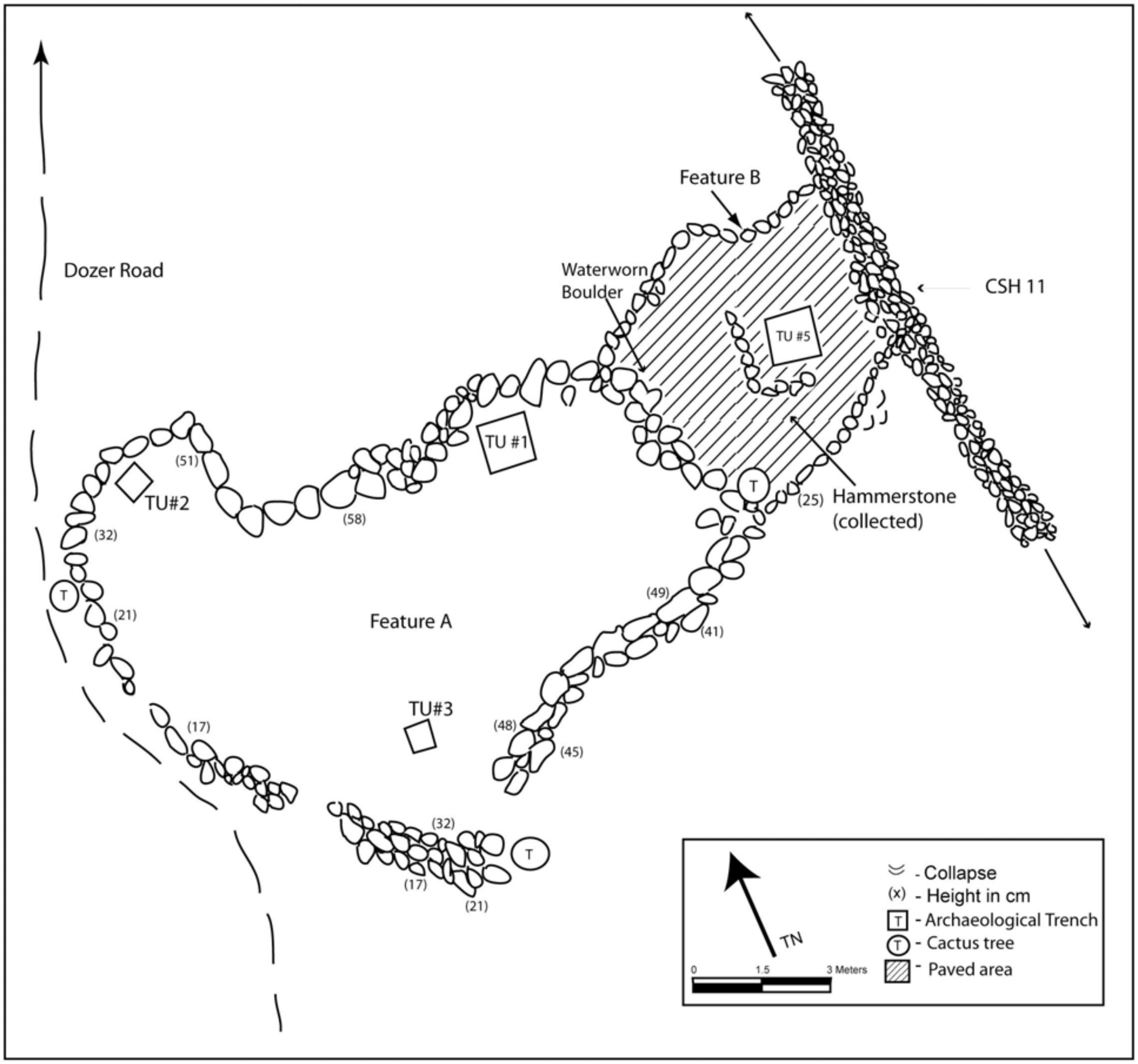


Figure 16. Plan View of SIHP Site 50-30-10-3791

Figure 17. SIHP Site 50-30-10-3791, remnant of enclosure, view east

SIHP SITE **50-30-10-3896**

FUNCTION: Agricultural

SITE TYPE: Wall

TOTAL FEATURES: 1

DIMENSIONS: 8.5 m by 0.3-.76 m

DESCRIPTION: This site has been reduced to a remnant by rock collecting. The entire length as recorded in 1985 could not be traced. Only discontinuous rock alignments are present (Figures 18, 19). Excavation potential is poor due to the condition of the site and its probable agricultural nature. The wall is in remnant condition.

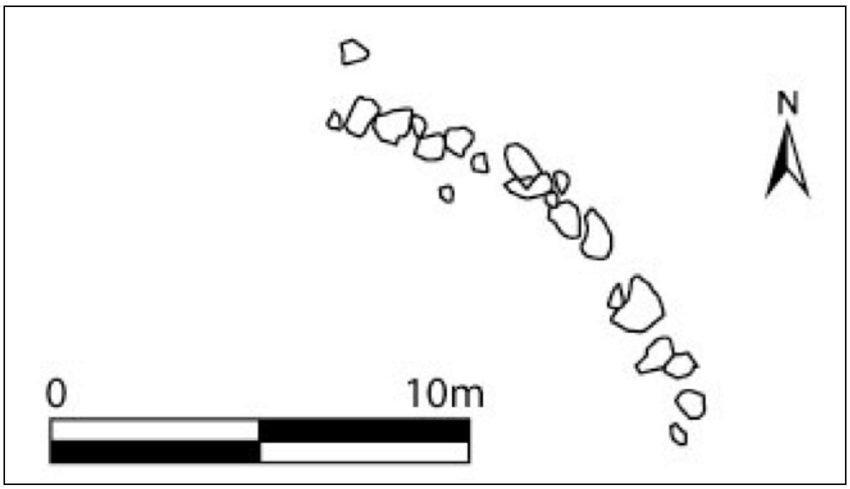


Figure 18. Plan View of SIHP Site 50-30-10-3896 as shown in Hammatt et al. (1985)

Figure 19. SIHP Site 50-30-10-3896, view southwest

SIHP SITE **50-30-10-3897**

FUNCTION: Habitation

SITE TYPE: C-Shape

TOTAL FEATURES: 1

DIMENSIONS: 7.6 m by 4.6 m

DESCRIPTION: SIHP Site 50-30-10-3897 has been virtually destroyed by rock collecting. Only an amalgamation of basalt cobbles remain. The footprint of the original C-Shape is difficult to discerne (Figures 20, 21). Dimensions are taken from 1985 Kōloa Bypass Road Report (Hammatt et al. 1985). The site is in poor condition.

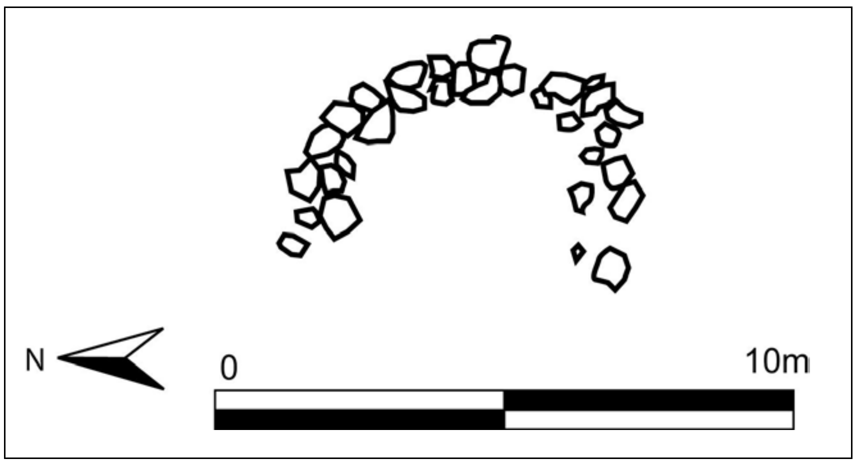


Figure 20. Plan View of SIHP Site 50-30-10-3897 as recorded in Hammatt et al. (1985)

Figure 21. SIHP Site 50-30-10-3897 view northeast.

SIHP SITE **50-30-10-3898**

FUNCTION: Agricultural (Remnant)

SITE TYPE: Mound

TOTAL FEATURES: 1 (Remaining)

DIMENSIONS: 2.1 m by 4.3 m

DESCRIPTION: Feature A could not be relocated, and was likely destroyed by bulldozing and rock collecting.

Feature B was formorly described as a section of an agricultural wall (Hammatt et al. 1985). The feature has been almost totally destroyed by rock collecting and possible bulldozing. Only an amorphous scatter of cobbles marks the former location.

SIHP SITE **50-30-10-3899**

FUNCTION: Agriculture

SITE TYPE: Enclosure

TOTAL FEATURES: 1 (Remaining)

DIMENSIONS: Feature B 18 m by 18 m

DESCRIPTION: Feature A could not be located and as presumably destroyed by bulldozing and/or rock collecting. Dimensions taken from 1985 Kōloa Bypass Road Report. (Hammatt et al. 1985).

Feature B was described as a roughly circular agricultural enclosure. A bulldozed road running from East to West cuts through the southern portion of the structure. Most of the structural boulders from the enclosure have been removed, presumably by rock collectors. The footprint of the structure is still discernable, marked by amalgamations of basalt cobbles. Excavation potential appears poor because the majority of the area enclosed by the structure is exposed bedrock. No surface cultural material was observed (Figures 22, 23).

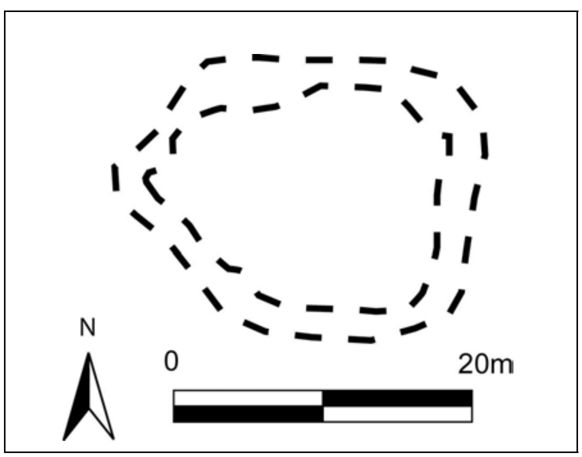


Figure 22. Plan View of SIHP Site 50-30-10-3899 B (dashed line shows cobble remnants marking former outline of site)

Figure 23. SIHP Site 50-30-10-3899, Feature B, view northeast

SIHP SITE **50-30-10-3900**

FUNCTION: Boundary marker

SITE TYPE: Wall

TOTAL FEATURES: 1

DIMENSIONS: 260 m by 0.6/1.4 m

DESCRIPTION: SIHP Site -3900 is a stacked boulder wall that may mark the boundary between *ahupua'a* of Kōloa and Weliweli. It has 6-8 vertical courses. Thirty meters of the southern end has been heavily impacted by rock collecting, with only a single course remaining. There are several other breaches along its length. Site -3900 is in fair condition. The wall continues *mauka* beyond the project area (see Figure 6).

SIHP SITE **50-30-10-3905**

FUNCTION: Habitation/Agriculture

SITE TYPE: C-Shapes and Terrace

TOTAL FEATURES: 3

DIMENSIONS: (Feat. A) 9.4 m by 5.3 m, (Feat. B) 6.1 m by 3.7 m, (Feat. C) 3.9 m by 6.4 m

DESCRIPTION: Feature A of SIHP Site 50-30-10-3905 is a C-Shaped structure in fair condition (Figure 24).

The wall of the C-Shaped structure is constructed on a bedrock boulder outcrop of small to medium basalt boulders stacked one to four courses high to a maximum height of 1.32 meters. The opening of the C-Shape faces southwest and the interior surface is lined and consists of bedrock boulders with a few basalt cobbles. There are little pockets of soil present on the interior surface. The site is located just north of Feature B of SIHP Site 50-30-10-3905 and shares its wall with feature B as well.

Feature B of SIHP Site 50-30-10-3905 is a C-Shaped structure. The wall of the C-Shape is constructed on a bedrock outcrop of small to medium height of 1.24 meters. Some parts of the wall has collapsed. The opening of the C-Shape faces west. The interior surface gently slopes to the southwest and consists of loose soil, vegetation, and a few small to medium sized basalt boulders. It is likely that the boulders on the interior surface were part of the structure at one time. The site is located just south of and shares a wall with Feature A. It is just west of Feature C.

Feature C of SIHP Site 50-30-10-3905 is a rectangular shaped terrace. The retaining wall of the terrace is constructed of medium to large basalt boulders stacked one to two courses high to a maximum height of 0.57 meters. The interior surface of the terrace is level and paved with medium to large basalt cobbles. The terrace is located on a bedrock boulder outcrop just east of Feature B.

A single excavation (Test Unit 6) was undertaken at site -3905. 8.7 g of midden, two volcanic glass flakes, and 3.2 g of charcoal were recovered from Test Unit 6.

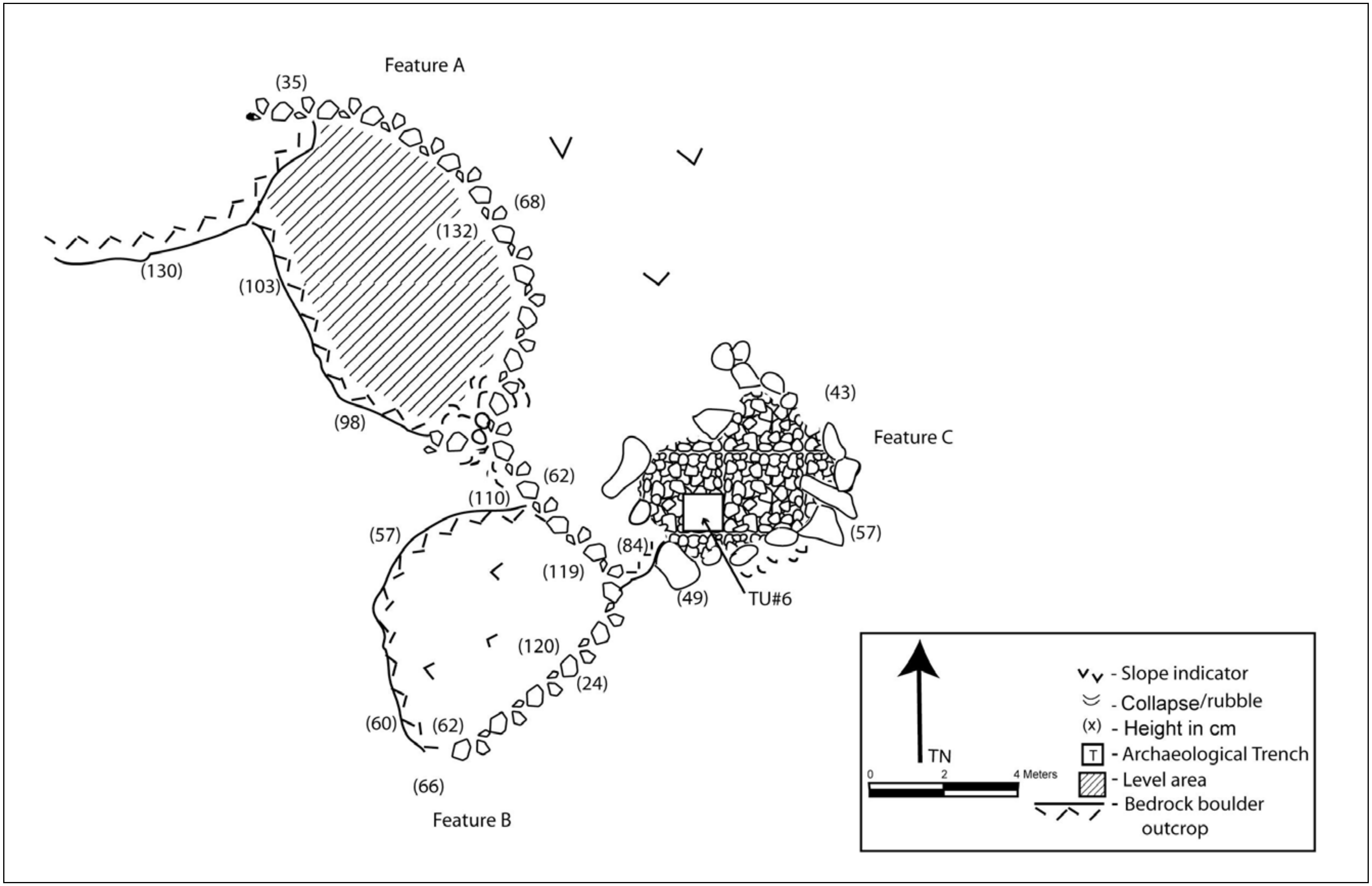


Figure 24. SIHP Site 50-30-10-3905, plan view map of Feature A-C

VI. EXCAVATION AND LAB RESULTS

In all, six test units were excavated for the subsurface testing portion of the inventory survey (Table 4). The six test units were situated within five sites [-3766 B (C-shape); -3770 Features A and B (C-shape and terrace); -3785 (enclosure); -3791 (C-shape); -3905 (C-shape)] and excavated to sterile sediments or bedrock. All midden, charcoal and artifacts were encountered within the Stratum II cultural layer.

Table 4. Sites Tested and Results from Subsurface Testing

Test Unit	SIHP Site	Findings
1	-3766 B (C-shape)	119.4 g total midden; 95.6 g marine invertebrate; 20.3 g echinoderm; 1.1 g kukui endocarp; 0.1 g small mammal bone; 0.7 g bird; 1.2 g *Scaridae sp*.; 0.4 g unidentified fish
2	-3770 A (C-shape)	2 volcanic glass flakes
3	-3770 B (Terrace)	54.1 g total midden; 50.0 g marine invertebrate; 3.6 g echinoderm; 0.3 g rat bone; 0.1 g small mammal; 0.1 g fish; also 55 g charcoal;
4	-3785 (Enclosure)	none
5	-3791 (Platform)	31.8 g total midden; 31.2 marine invertebrate; 0.2 g echinoderm; 0.4 g small to medium mammal; 13.6 g charcoal and one basalt hammerstone recovered (97.4 g)
6	-3905 (Terrace)	8.7 g total midden; 4.8 g marine invertebrate; 0.3 g kukui; 0.4 g medium mammal; 3.2 g charcoal; 2 volcanic glass flakes

A. Stratigraphy and Lab Results

1. Test Unit 1

Test unit 1 was excavated within SIHP Site -3766 Feature B (C-shape). The C-shape was part of a probable agricultural complex that included a large terrace complex. A 1 m by 1 m test unit was placed within the interior of the feature and was excavated to sterile sediments (Stratum III).

The stratigraphic sequence encountered within the test unit consisted of three distinct sediment layers (Figure 25). Stratum I consisted of a 9 cm thick dark brown sandy loam that contained no cultural materials and layers. Stratum II consisted of 17 cm thick very dark brown silt loam cultural layer that contained abundant shell midden and a charcoal lens. Stratum III consisted of a sterile dark brown silt layer. Excavation was halted 20 cm into the stratum.

In total, 119.4 g of midden was recovered during the subsurface testing (Table 5). Of the 119.4 g, marine invertebrate shell accounted for 95.6 g (80.0%), echinoderm accounted for 20.3

g (17.0%), kukui endocarp accounted for 1.1 g (1.0%); *Scaridae sp.* accounted for 1.2g (1.0%), one bird bone shaft accounted for 0.7 g (<1.0%), unidentified fish bone accounted for 0.4 g (<1.0%), and small mammal accounted for 0.1 g (<1.0).

In addition, two branch coral manuports, weighing 12.3 g, and a discreet charcoal lens were also encountered within Stratum II (9-26 cmbs) of Test Unit 1. The charcoal lens was collected for 14C radiocarbon dating analysis. A 55.8 g sample of charcoal was submitted to Beta Analytic and returned a 2 sigma (95% probability) calibrated date range of A.D. 1660 to 1950.

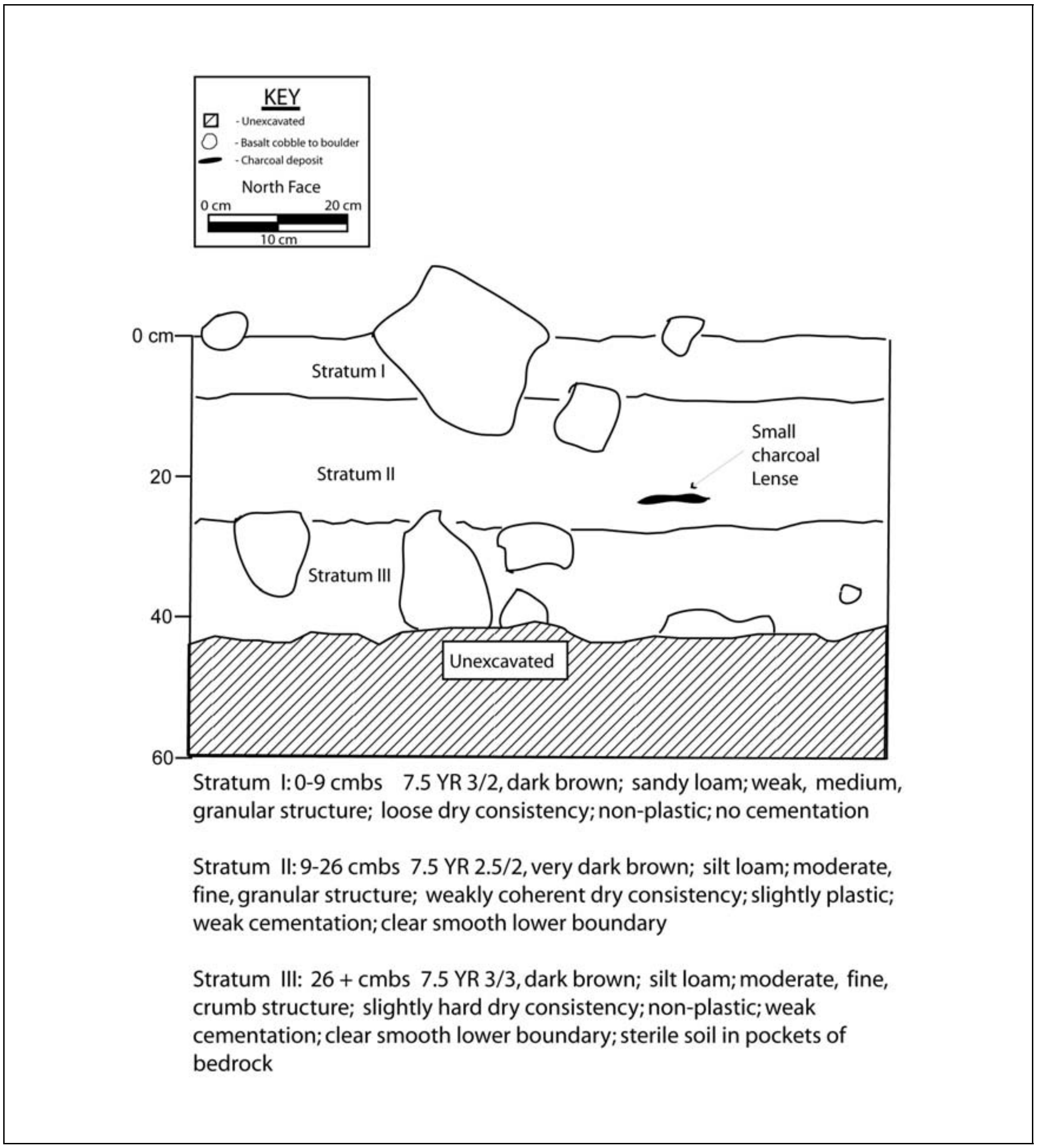


Figure 25. Profile of north wall of Test Unit 1, SIHP Site -3766

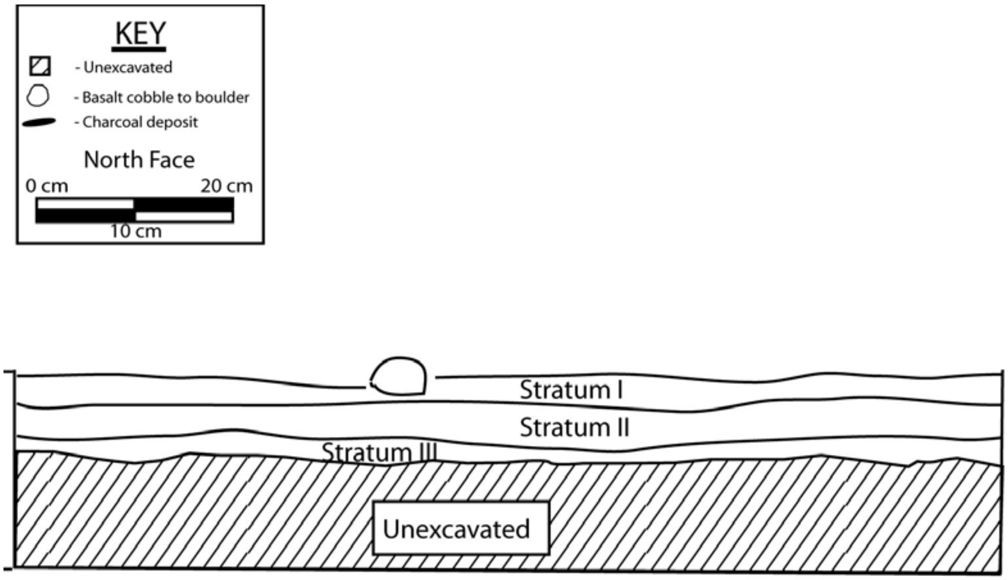
Table 5. Test Unit 1, SIHP Site -3769 Midden Results

Midden Taxa	Stratum	Depth (cmbs)	Number of Pieces	Weight (g)
Conus sp	II	9-26	3	7.4
Cymatium sp	II	9-26	1	0.9
Cypraeidae	II	9-26	12	12.7
Isognomon sp	II	9-26	5	3.8
Nerita picea	II	9-26	27	9.2
Strombus maculatus	II	9-26	2	1.8
Thaididae sp	II	9-26	1	1.2
Trochus inetxtus	II	9-26	1	1
Turbo sandwichensis	II	9-26	10	8.8
Unidentified shell midden	II	9-26		48.8
Echinoderm	II	9-26	54	20.3
Kukui	II	9-26	11	1.1
small mammal	II	9-26	2	0.1
bird	II	9-26	1	0.7
Scaridae sp.	II	9-26	2	1.2
unidentified fish	II	9-26	2	0.4
Total				119.4

2. Test Unit 2

Test Unit 2 was excavated within SIHP Site -3770 Feature A (C-shape). The C-shape had been heavily disturbed by rock collectors and only a remnant of the former C-shape existed. A 1 m by 1 m test unit was placed within the interior of the feature and was excavated to sterile sediments (Stratum III).

The stratigraphic sequence encountered within the test unit consisted of three distinct sediment layers (Figure 26). Stratum I consisted of a 3 cm thick dark brown sandy loam that contained no cultural materials and layers. Stratum II consisted of a 4 cm thick dark brown silt loam cultural layer that contained two small volcanic glass fragments. Stratum III consisted of a sterile dark brown silt layer. Excavation was halted 5 cm into the stratum.



Stratum I: 0-3 cmbs 7.5 YR 2.5/2, A Horizon, Very dark brown; silt loam; weak, fine, granular structure; loose dry consistency; non-plastic; no cementation; clear wavy lower boundary; Terrestrial origin

Stratum II: 3-7 cmbs 7.5 YR 3/2, Dark brown; clay loam; moderate, granular structure; soft dry consistency; slightly plastic; weak cementation; clear smooth lower boundary; Terrestrial origin

Stratum III: 6-9 cmbs 7.5 YR 3/3, Dark brown; clay loam; structureless, medium, crumb structure; slightly hard dry consistency; slightly plastic; strong cementation; Terrestrial origin

Figure 26. Profile of north wall of Test Unit 2, SIHP Site -3770 A

3. Test Unit 3

Test Unit 3 was excavated within SIHP Site -3770 Feature B (habitation terrace). The terrace was part of a probable habitation complex that included an additional C-shape (Feature A). A 1 m by 1 m test unit was placed within the interior of the feature and was excavated to sterile sediments (Stratum III).

The stratigraphic sequence encountered within the test unit consisted of three distinct sediment layers (Figure 27). Stratum I consisted of a 5 cm thick dark brown sandy loam layer that contained no cultural materials. Stratum II consisted of 21 cm thick very dark brown clay loam cultural layer that contained abundant shell midden and a charcoal lens. Stratum III consisted of a sterile dark brown clay layer. Excavation was halted 10 cm into the Stratum III.

In total, 54.1 g of midden was recovered during the subsurface testing (Table 6). Of the 54.1 g, marine invertebrate shell accounted for 50.0 g (92.4%), echinoderm accounted for 3.6 g (6.7%), rat bone accounted for 0.3 g (0.2%), small mammal accounted for 0.1 g (0.1%) and unidentified fish accounted for 0.1 g (0.1%).

In addition, 55.0 g of charcoal was recovered from Stratum II of Test Unit 3. The charcoal was collected for 14C radiocarbon dating analysis. The charcoal sample was submitted to Beta Analytic and returned a 2 sigma (95% probability) calibrated date range of A.D. 1490 to 1680, A.D. 1770 to 1800 and A.D. 1940 to 1950.

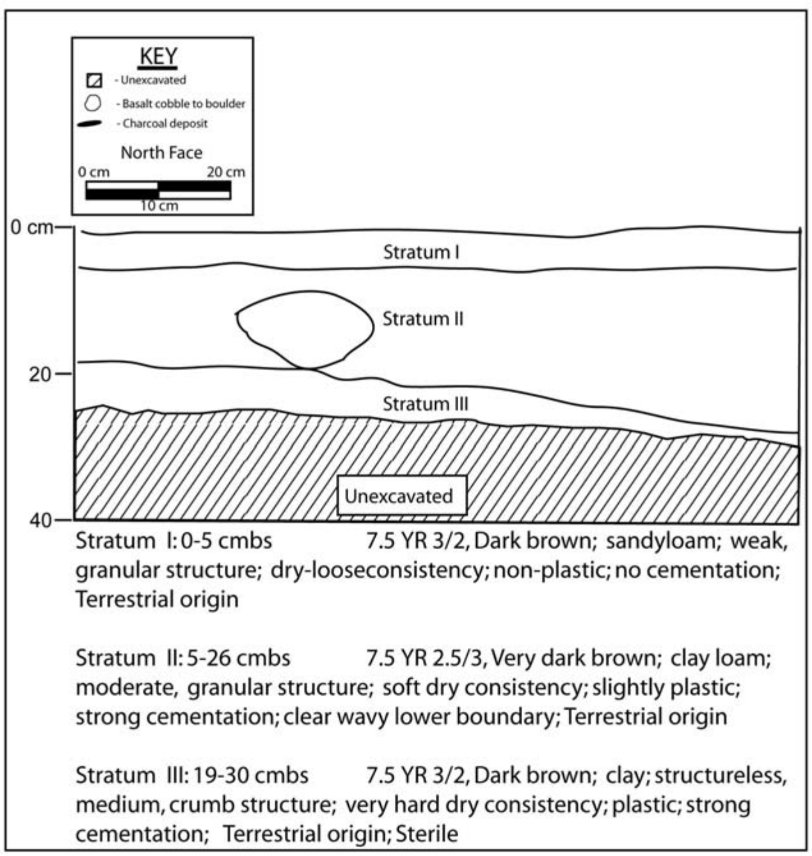


Figure 27. Profile of north wall of Test Unit 3, SIHP Site -3770 B

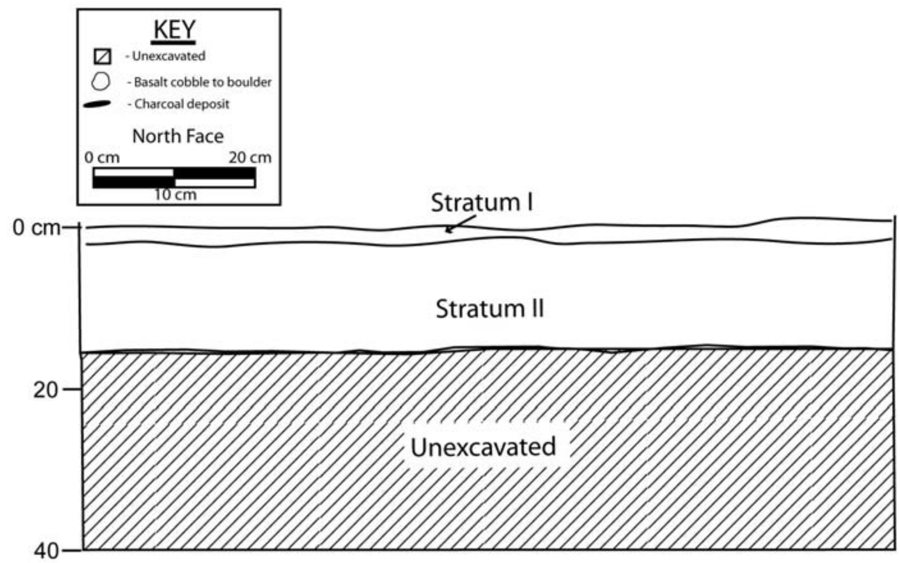
Table 6. Test Unit 3, SIHP Site -3770 B Midden Results

Midden Taxa	Stratum	Depth (cmbs)	Number of Pieces	Weight (g)
Cypraeidae	II	5-26	6	6.4
Isognomon sp	II	5-26	0.8	2
Littorina pintado	II	5-26	1	0.1
Modiolos matris	II	5-26	1	0.1
Nerita picea	II	5-26	24	4.9
Strombus maculatus	II	5-26	2	1.4
Thaididae sp	II	5-26	3	1.5
Trochus inetxtus	II	5-26	3	0.2
Turbo sandwichensis	II	5-26	16	15.6
Unidentified shell midden	II	5-26		17.8
Echinoderm	II	5-26	28	3.6
Rattus exulans	II	5-26	9	0.3
small mammal	II	5-26	1	0.1
fish bone	II	5-26	1	0.1
Total				54.1

4. Test Unit 4

Test Unit 4 was excavated within SIHP Site -3785 The enclosure was part of a probable habitation and agricultural complex that once included a portion of a lo‘i wall (destroyed). A 1 m by 1 m test unit was placed within the interior of the feature and was excavated to sterile sediments (Stratum III).

The stratigraphic sequence encountered within the test unit consisted of two distinct sediment layers (Figure 28). Stratum I consisted of a 2 cm thick very dark brown silt loam layer that contained no cultural materials. Stratum II consisted of a 13 cm thick dark brown clay loam. No cultural materials or artifacts were encountered during the excavation and screening of sediments. Excavation was halted 13 cm into the Stratum II.



Stratum I: 0-2 cmbs 7.5 YR 2.5/2, A1 Horizon, Very dark brown; silt loam; weak, medium, single grain structure; loose dry consistency; non-plastic; no cementation; clear smooth lower boundary; Terrestrial origin

Stratum II: 2-15 cmbs 7.5 YR 3/3, Dark brown; clay loam; moderate, medium, crumb structure; hard dry consistency; slightly plastic; strong cementation; Terrestrial origin

Figure 28. Profile of north wall of Test Unit 4, SIHP Site -3785

5. Test Unit 5

Test Unit 5 was excavated within SIHP Site -3791. The Platform was located on top of a paved terrace that was part of a probable habitation complex that included an additional terraced/enclosed area (destroyed). A 1 m by 1 m test unit was placed within the interior of the feature and was excavated to sterile sediments (Stratum III).

The stratigraphic sequence encountered within the test unit consisted of three distinct sediment layers (Figure 29). Stratum I consisted of a 21 cm thick very dark brown silt loam layer that contained scarce shell midden. Stratum II consisted of 21 cm thick very dark brown clay loam cultural layer that contained scarce shell midden and a charcoal lens. Stratum III consisted of a sterile dark brown clay loam layer. Excavation was halted 15 cm into the Stratum III.

In total, 31.8 g of midden was recovered during the subsurface testing (Table 7). Of the total, marine invertebrate shell accounted for 31.2 g (98.1%), echinoderm accounted for 0.2 g (0.7%), and small mammal accounted for 0.2 g (0.7%). A total of 13.6 g of charcoal were also collected during excavation, though this sample was not from a discreet lens. In addition to the midden and encountered in Test Unit 5, a small basalt hammerstone, weighing 97.4 g, was collected on the surface of SIHP Site -3791.

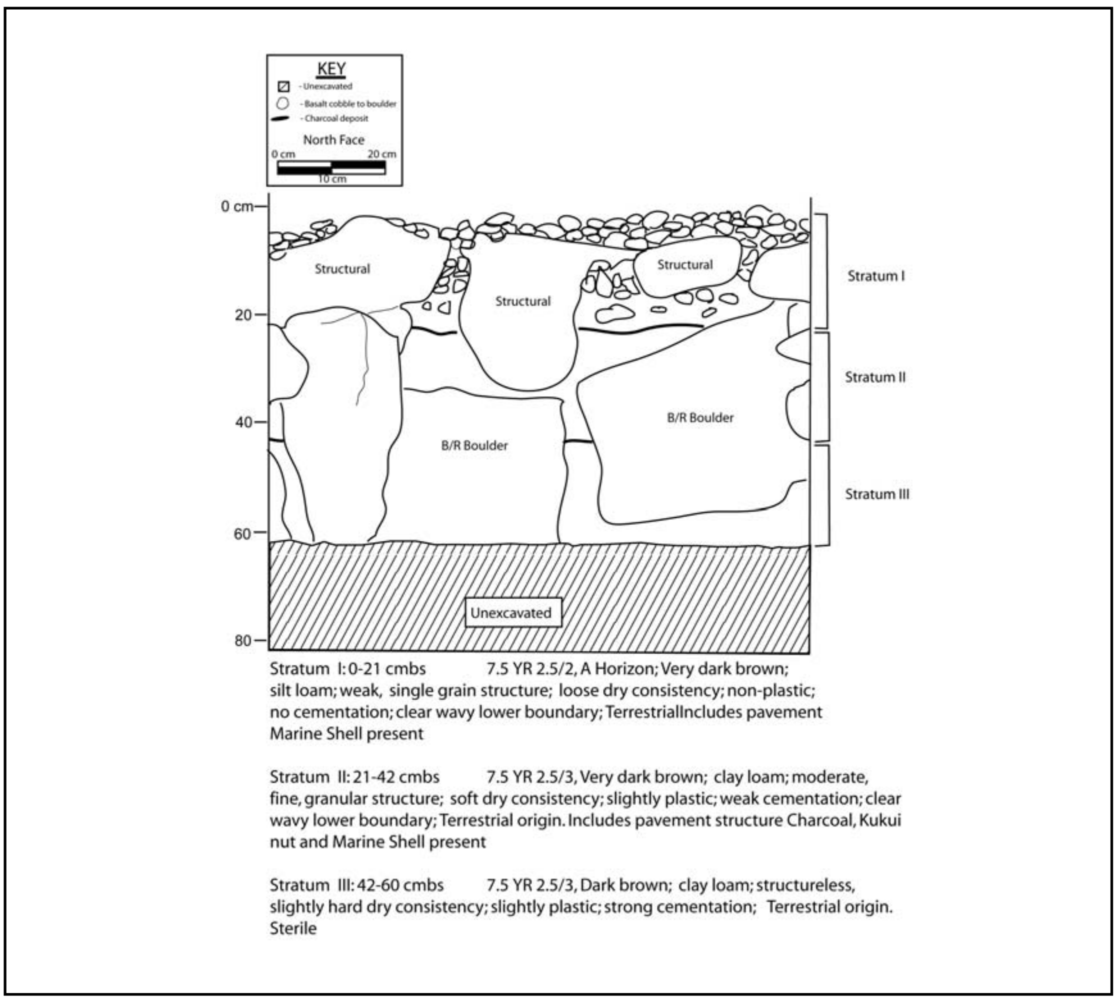


Figure 29. Profile of north wall of Test Unit 5, SIHP Site -3791

Table 7. Test Unit 5, SIHP Site -3791 Midden Results

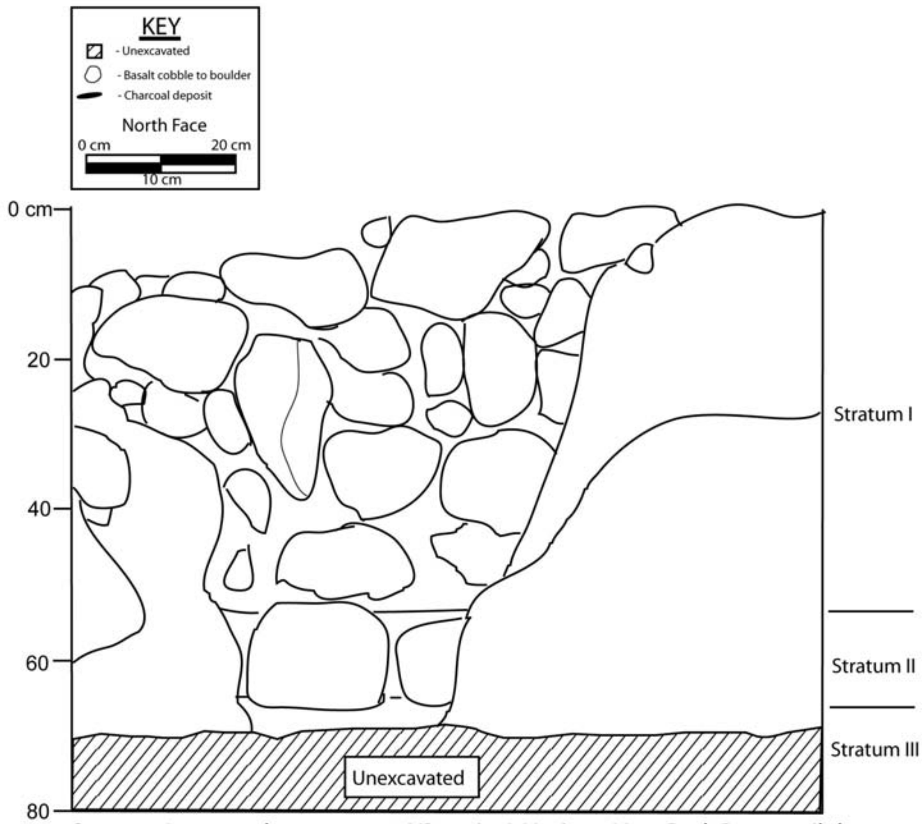
Midden Taxa	Stratum	Depth (cmbs)	Number of Pieces	Weight (g)
Conus sp	II	21-42	3	1.6
Cypraeidae	II	21-42	1	1.6
Littorina pintado	II	21-42	2	0.2
Nerita picea	II	21-42	3	0.2
Thaididae sp	II	21-42	3	4.5
Turbo sandwichensis	II	21-42	4	4.4
Unidentified shell midden	II	21-42		18.8
Echinoderm0.5	II	21-42	2	0.2
small mammal	II	21-42	1	0.4
Total				31.8

6. Test Unit 6

Test Unit 6 was excavated within SIHP Site -3905 Feature C (terrace). The terrace was located adjacent to two C-shapes. The interior of the terrace is leveled with medium to large cobbles. A 1 m by 1 m test unit was placed within the interior of the feature and was excavated to sterile sediments (Stratum III).

The stratigraphic sequence encountered within the test unit consisted of three distinct sediment layers (Figure 30). Stratum I consisted of a 56 cm thick very dark brown silt loam layer that contained abundant (90%) basalt cobbles. Stratum II consisted of 10 cm thick very dark brown clay loam cultural layer that contained scarce shell midden. Stratum III consisted of a sterile dark brown clay loam layer. Excavation was halted 4 cm into the Stratum III.

In total, 5.5 g of midden was recovered during the subsurface testing (Table 8). Of the total, marine invertebrate shell accounted for 4.8 g (87.3%), medium mammal accounted for 0.4 g (7.3%) and kukui endocarp accounted for 0.3 g (5.5%). A total of 3.2 g of charcoal were also collected during excavation, though this sample was not from a discreet lens and was not submitted for radiocarbon dating. In addition to the midden, 2 volcanic glass fragments (1.2 g) were encountered within Stratum II.



Stratum I: 0-56 cmbs 7.5 YR 2.5/2, A Horizon; Very Dark Brown; silt loam; structureless, loose dry consistency; non-plastic; no cementation; clear smooth lower boundary; Terrestrial origins Includes terrace paving and structure

Stratum II: 56-66 cmbs 7.5 YR 2.5/3, Very dark brown; clay loam; moderate, fine, granular structure; soft dry consistency; slightly plastic; weak cementation; clear wavy lower boundary; Terrestrial origin Charcoal, marine shell, Kukui, bone, fish scale, and volcanic glass encountered

Stratum III: 66-70 cmbs 7.5 YR 3/3, Dark brown; clay loam; moderate, medium, granular structure; slightly hard dry consistency; plastic; strong cementation; Terrestrial origin. Sterile

Figure 30. Profile of north wall of Test Unit 6, SIHP Site -3905

Table 8. Test Unit 6, SIHP Site -3905 Midden Results

Midden Taxa	Stratum	Depth (cmbs)	Number of Pieces	Weight (g)
Cypraeidae	II	55-66	1	1.5
Nerita picea	II	55-66	2	0.1
Terebra sp	II	55-66	1	0.2
Trochus intextus	II	55-66	1	0.2
Turbo sandwichensis	II	55-66	1	0.5
Unidentified shell midden	II	55-66	9	2.3
Kukui	II	55-66	1	0.3
med. mammal	II	55-66	1	0.4
Total				5.5

B. Charcoal

Four charcoal samples were collected during the subsurface testing portion of the inventory survey, two of which were suitable for radiocarbon dating. (Table 9)

Table 9. Charcoal Catalogue

Accession Number	Test Unit	Stratum	Depth	Material	Weight (g)	Calibrated Date (95% probablility)
KOLO24TU1 C1*	1	II	9-26	Charcoal	55.8	AD 1660-1950
KOLO24TU3 C2*	3	II	5-26	Charcoal	55	AD 1490-1680 AD 1770-1800 AD 1940-1950
C3	5	II	21-42	Charcoal	13.6	
C4	6	II	56-66	Charcoal	3.2	
Total					127.6	

* denotes sample was sent to Beta Analytic for radiocarbon dating analysis

Both charcoal samples sent for radiocarbon dating (KOLO24TU1C1 and KOLO24TU3C2) had inconclusive radiocarbon dates. (Figures 31, 32) Sample KOLO24TU1C1 has an intercept date range of 1690-1950 AD, with a 68% probability ranging from 1670-1950 AD. Sample KOLO24TU3C2 has an intercept date range of 1650 AD, with a 68% probability ranging from 1330-1660 AD, however, there is a 95% probability date range of 1940-1950 AD as well. Neither sample reliably supports that indigenous occupation occurred in the project area.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-19.4:lab. mult=1)

Laboratory number: Beta-199107

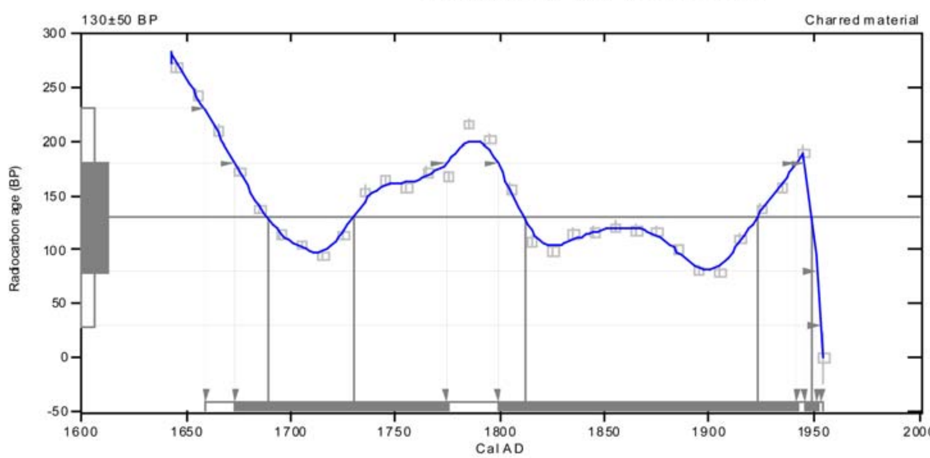
Conventional radiocarbon age: 130±50 BP

2 Sigma calibrated result: (95% probability) Cal AD 1660 to 1950 (Cal BP 290 to 0)

Intercept data

Intercepts of radiocarbon age with calibration curve:
Cal AD 1690 (Cal BP 260) and
Cal AD 1730 (Cal BP 220) and
Cal AD 1810 (Cal BP 140) and
Cal AD 1920 (Cal BP 30) and
Cal AD 1950 (Cal BP 0)

1 Sigma calibrated results: (68% probability)
Cal AD 1670 to 1770 (Cal BP 280 to 180) and
Cal AD 1800 to 1940 (Cal BP 150 to 10) and
Cal AD 1950 to 1950 (Cal BP 0 to 0)



References:
Database used
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Calibration Database
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Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory
4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

Figure 31. Results of radiocarbon dating for charcoal sample KOLO24TU1C1.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-11.1:lab. mult=1)

Laboratory number: Beta-199108

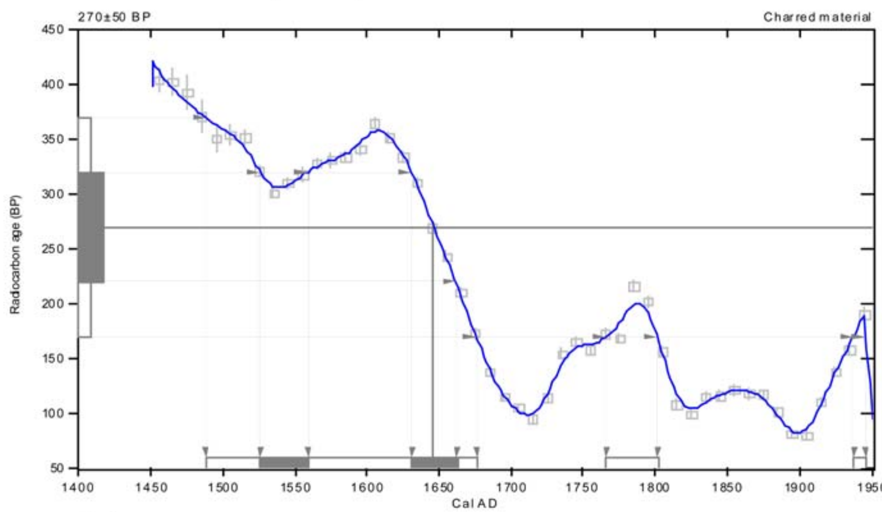
Conventional radiocarbon age: 270±50 BP

2 Sigma calibrated results: (95% probability) Cal AD 1490 to 1680 (Cal BP 460 to 270) and
Cal AD 1770 to 1800 (Cal BP 180 to 150) and
Cal AD 1940 to 1950 (Cal BP 10 to 0)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1650 (Cal BP 300)

1 Sigma calibrated results: (68% probability) Cal AD 1530 to 1560 (Cal BP 420 to 390) and
Cal AD 1630 to 1660 (Cal BP 320 to 290)



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Calibration Database
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Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory

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Figure 32. Results of radiocarbon dating for charcoal sample KOLO24TU3C2.

C. Summary

All of the recovered cultural remains (artifacts, midden, bone and charcoal) excavated during the inventory survey were encountered within Stratum II. The stratigraphic model for the project area is that Stratum II, a cultural layer, is sandwiched between a sterile A horizon (Stratum I) and a C horizon (Stratum III). Radiocarbon dating results did little to support the stratigraphic sequence or occupational model of the area. The amount of recovered cultural remains reflects that the sites in question were used primarily for temporary habitation, including limited food preparation/ consumption and lithic reduction related to tool making.

VII. SUMMARY

Kōloa Ahupua‘a is described by early archaeologists as “in a high state of cultivation”. The evidence of field systems (*l‘oi*) and irrigation channels (*auwai*) have been found throughout sections of Kōloa. The project area’s location (approximately 400 m to the coast) is indicative of both habitation and agricultural features. *Kuleana* awards indicate that habitation and agriculture were occurring around the subject property suggesting that a broad range of site types may be present

From previous archaeological studies and historic accounts it appears that habitation and intensive irrigated agriculture were widespread in central and coastal Kōloa utilizing the opportunity to develop an extensive irrigated complex (the Kōloa Field System) off of Waikomo Stream. As Judd (1935) asserts, it is likely that low inland areas were used for less intensive cultivation patches of sweet potato, *pia*, and *wauke* and the gathering of *hala, kukui* and other resources. With this in mind, the types of archaeological sites and/or cultural materials within the project area were expected include both historic and pre-contact surface features such as walls, mounds, terraces, channels (*auwai)* associated with agriculture, as well as, other structures consistent with temporary habitations or field houses (c-shapes, small terraces, and small scale enclosures) and permanent habitations (large scale enclosures, terraces, and house platforms).

Hammatt et al. (1978) conducted a survey in the Kiahuna lands area and identified 583 archaeological sites including 175 enclosures, 108 house platforms, *auwai,* fields, terrace plots, and rock mounds. The subject property was possibly part of this survey. Hammatt et al. (1991) conducted an archaeological reconnaissance on an adjacent parcel to the northwest boundary of the subject parcel. This reconnaissance noted extensive modern land modification and no significant findings. In 1985 Hammatt et al. conducted an archaeological inventory survey at the same area of the Kōloa-Po‘ipū Bypass Road. This survey with subsurface testing identified a total of 47 archaeological features. These findings were consistent with what have been recorded by Hammatt et al. (1978).

During a 2003 archaeological assessment of the parcel (Tulchin et al. 2003) it was observed that the known locations of several previously documented archaeological sites were covered in large boulder piles, including ARCH Sites 814, 815, 819-821, 824, 825, 827-831, 834, 838, and portions of SIHP Site 50-30-10-966 (see Figures 5, 6, see Table 2). The boulder stockpiles had been created sometime after 1985. The total impact to these previously identified sites was unclear at the time of assessment.

Archaeological monitoring was conducted by CSH, at the request of SHPD/DLNR Kaua‘i Archaeologist Nancy McMahon, during the removal the boulder stockpiles. Work began on Oct. 12, 2004 and was completed on Nov. 8, 2004. During the course of monitoring, none of the sites in question were encountered. Based on observation, the sites were bulldozed prior to the creation of the stockpiles (see Figures 5, 6). Boulders in the stockpile still had a red patina, indicating that the piling activities were taking place until very recently. Thus, based on observations during archaeological monitoring, ARCH Sites 814, 815, 819-821, 824, 825, 827-831, 834, and portions of SIHP Site 50-30-10-966 including associated subsurface deposits, no longer exist due to the bulldozing and boulder stockpiling activities.

In addition to the thirteen sites destroyed by bulldozing and boulder stockpiling activities, five additional sites [SIHP Site -3786 (ARCH Site 833), -3788 (ARCH Site 835), -3792 (ARCH

Site 839), -3793 (ARCH Site 840), and -3795 (ARCH Site 842)] were not located during the present study. It is presumed that these sites were destroyed during previous road construction, which occurred prior to the present study. Of the 33 previously documented sites in the project area, 15 remain and 18 no longer exist. One site was newly identified in this study (SIHP site -3905)

Of the sixteen located sites 10 have a habitation function, 3 have an agricultural function, one has a storage function, and one is a probable *ahupua'a* boundary. Site complex -966 has both an agricultural and habitation function.

During the present inventory survey, six test units were excavated at five sites (-3766 A, -3770 A&B, -3785, -3791, -3905). Moderate amounts, 214 g, if inner coastal shell midden and scant amounts of small mammalian and avian bone was collected from the excavation units. In addition, four volcanic glass flakes, one basalt hammerstone and 127.6 g of charcoal was collected from the six test units. Two charcoal samples (KOLO24TU1C1, KOLO24TU3C2) were sent for radiometric dating. Both samples had inconclusive return dates and do not reliably support any type of habitation model (see Table 9, see Figures 31, 32).

The material finds recovered during the survey are indicative of an agriculture field with associated habitation and temporary habitation. Though material evidence of historic occupation was not encountered during the inventory survey, the Kōloa area is known to have been heavily modified to allow commercial agriculture (sugar cane, victual trade goods) and extensive ranching in the historic era (see Section II).

VIII. SIGNIFICANCE AND RECOMMENDATIONS

A. Significance

A total of sixteen sites of varied archaeological significance are present in the project area. Individual significance and recommended treatment are specified in Table 10 and Figure 33. Sites were evaluated for significance according to the broad criteria established for the National and State Registers. The five criteria are:

A Site reflects major trends or events in the history of the state or nation.

B Site is associated with the lives of persons significant in our past.

C Site is an excellent example of a site type.

D Site may be likely to yield information important in prehistory or history.

E Site has cultural significance; probable religious structures and/or burials present.

The initial significance assessments are based on functional interpretations of the sites and site types. All of the sites within the project area are considered significant.

Sites -966, -3766, -3769, -3770, -3771, -3775, -3779, -3785, -3790, -3791, -3896, -3897, -3898, -3899, and -3905 are considered significant under Criteria D. These sites are all likely to yield additional information pertinent to prehistory and/or history.

Site -3900, the probable *ahupua'a* boundary wall, is considered significant under Criteria C and D. It is an excellent example of traditional Hawaiian site types (Criterion C) and is likely to yield additional information important to prehistory or history (Criterion D).

Site -966 (complex) has been heavily impacted by rock collecting and bulldozing, yet portions of the site remain intact, within and outside of the current project area. The intact northern (*mauka*) portion of the site complex, located outside of, but adjoining, the current project area is considered significant under Criteria C and D. The complex contains a variety of habitation and agricultural features and is an excellent example of traditional Hawaiian site types (Criterion C) and is likely to yield additional information important to prehistory or history (Criterion D). Although Criterion C is no longer relevant for the remnants within the current project area, due to their poor condition, Criterion D is relevant, as the complex is likely to yield additional information important to prehistory or history.

B. Recommendations

1. No Further Work

Five sites are recommended for no further work. Sites -3771, -3775, -3779, -3896, and -3898 have been severely impacted by rock collecting with only remnants of the original sites remaining. The five sites have been mapped, photographed, described and their locations have been recorded using GPS technology.

2. Data Recovery

Of the sixteen sites documented during the inventory survey, nine are recommended for further data recovery work. Initial documentation of Sites -3766, -3769, -3770, -3785, -3790, 3791, -3897, -3899 and -3905 suggest that additional data collection (i.e. subsurface excavation, additional mapping) is necessary to fully understand the function of the sites and relationships between individual features in the larger site complexes.

3. Preservation

Two sites are recommended for preservation, site –3900 (the probable *ahupua‘a* boundary wall) and the -966 complex.

While the –966 complex has been heavily impacted by modern rock collecting and bulldozing and is in remnant condition, portions of the site remain intact. Within the project area, near the northern boundary, these remnants include the approximately 75 meters of the western stone enclosing wall which is still relatively intact (although it has been moderately impacted by rock collecting), a *lo‘i* wall, and an adjacent *‘auwai* (that runs along the eastern side of the wall). The *lo‘i* wall and adjacent *‘auwai* have been somewhat impacted by a bulldozed road and are not continuously traceable (see Figure 6). Outside of, but adjoining, the project area, the remnants of the site complex include the intact northern (*mauka*) portion of the site complex (see Figure 6).

The intact northern (mauka) portion was part of the Po‘ipūlani inventory survey (Hammatt et al. 1991) and for the most part the site remains intact. Thus, CSH recommends that the preservation of site -966 be focused on the remaining northern portion, as there is very little of the site left within the current project area.

Table 10. Site Significance and Recommendations (*Site tested during CSH 2004 Survey)

SIHP Site # 50-30-10-	Type	Function	Previous Work Done: Kiahuna (1978)	Previous Work Done: Kōloa-Po'ipū Bypass Road (1985)	Previous Work Done: Po'ipūlani (1991)	Present State (2004)	Recommendations (Significance)
966	Complex	Agriculture and habitation	located & described as individual features	located & described as -832 complex	located & described	Partially disturbed	Preserve remnant (C, D)
3766*	Wall, C-Shapes and Mound	Habitation	located & described			Intact	Data recovery (D)
3769	Walls, Terrace, Enclosure and Mound	Habitation	located & described			Intact	Data recovery (D)
3770*	C-shape and Terrace	Habitation	located & described			Intact	Data recovery (D)
3771	Mound	Habitation (Remnant)	located & described			Partially disturbed	No Further Work (D)
3775	Mound	Habitation (Remnant)	located & described			Partially disturbed	No Further Work (D)
3779	Enclosure	Storage	located & described			Remnant	No Further Work (D)
3785*	Enclosure	Agriculture	located & described	located & described	located & described, included in -966 complex	Partially disturbed	Data recovery (D)

SIHP Site # 50-30-10-	Type	Function	Previous Work Done			Present State (2004)	Recommendations (Significance)
			Kiahuna (1978)	Kōloa-Po‘ipū Bypass Road (1985)	Po‘ipūlani (1991)		
3790	C-shape	Habitation	located & described	located, described, & tested		Intact	Data Recovery (D)
3791*	Enclosure and Platform	Habitation	located & described	located, described, & tested		Intact	Data Recovery (D)
3896	Wall	Agriculture		located & described		Intact	No Further work (D)
3897	C-shape	Habitation		located & described		Partially disturbed	Data recovery (D)
3898	Mound	Agriculture (Remnant)	located	located & described		Partially disturbed	No Further work (D)
3899	Enclosure	Agriculture		located & described		Partially disturbed	Data Recovery (D)
3900	Wall	Probable ahupua‘a boundary	located	located & described		Intact	Preserve (C, D)
3905*	C-shapes and a terrace	Habitation				Intact	Data Recovery (D)

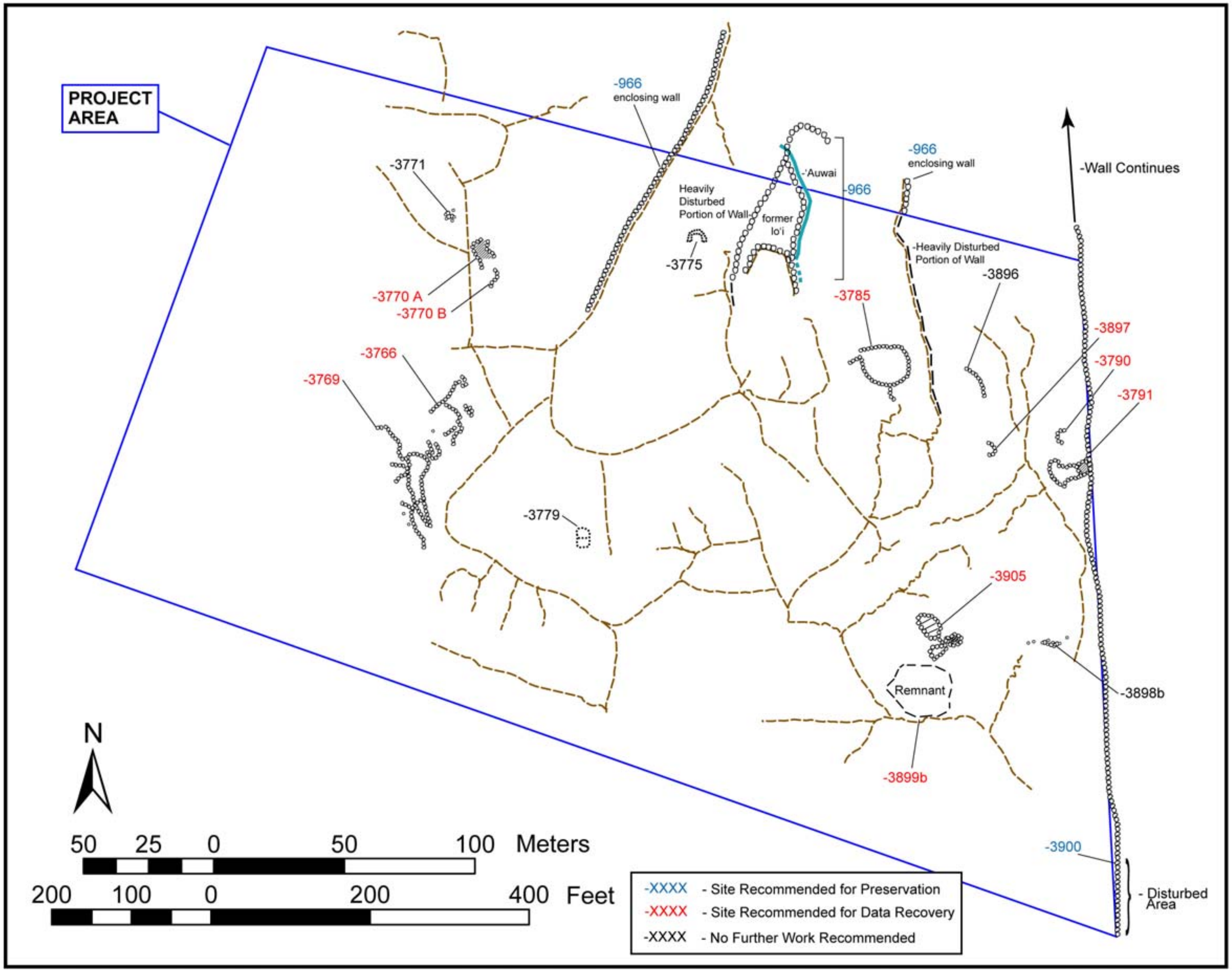

Figure 33. Map of remaining sites within project area with recommendations for further work

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Appendix E

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

January 11, 2006

Hal Hammatt, PhD
Cultural Survey Hawaii, Inc.
PO Box 1114
Kailua, Hawaiʻi 96734

LOG NO: 2006.0067
DOC NO: 0512NM61
Archaeology

Dear Dr. Hammatt:

**SUBJECT: Chapter 6E-42 Historic Preservation Review –
Archaeological Inventory Survey Report An 8.633 Acre Parcel at Koloa
(CSH, Hill, Tulchin, Tulchin and Hammatt 2005)
Koloa Ahupuaʻa, Kona District, Island of Kauaʻi
TMK: (4) 2-8-014:001 mauka portion**

We are in receipt of the aforementioned revised archaeological inventory survey report for our review. We received the report on December 20, 2005.

One historic site (50-30-10-3926 – plantation era elevated metal irrigation flume) was identified in the project area. The report thoroughly documents this site and the surrounding land use. No further archaeological work is necessary.

This report is approved.

If you have any questions, please call Nancy McMahon at 808-742-7033.

Aloha,

Melanie A. Chinen, Administrator
State Historic Preservation Division

NM:jen

c: Ian Costa, County of Kauai

ARCHAEOLOGICAL INVENTORY SURVEY FOR AN 8.633 ACRE PARCEL AT KŌLOA

Kōloa Ahupuaʻa, Kona District, Island of Kauaʻi

(TMK: (4) 2-8-014: 001 *Mauka* Portion)

Prepared for
Eric A. Knudsen Trust
Mr. Stacey Wong

Prepared by
Robert R. Hill, B.A.
Todd Tulchin, B.S.
Jon Tulchin, A.S.
and
Hallett H. Hammatt, Ph.D

Cultural Surveys Hawaiʻi, Inc
Wailuku, HI.
(CSH Job Code: KOLO 51)

September 2005

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Management Summary

Report Reference	An Archaeological Inventory Survey of an 8.633 Acre Parcel at Kōloa Ahupua‘a, Kona District, Island of Kaua‘i, by Robert R. Hill, B.A., Todd Tulchin, B.S., Jon Tulchin, A.S., and Hallett H. Hammatt, Ph.D. Prepared for the Eric A. Knudsen Trust, c/o Mr. Stacey Wong.
Project Number	CSH Job Code: KOLO 51
Location	Kaua‘i Island, Kona District, Kōloa Ahupua‘a, TMK: (4) 2-8-014: 001, *Mauka* portion, USGS 1:24000 topographic map (Kōloa Quadrangle).
Date Submitted	September 2005
Permit Number	Hawai‘i State Historic Preservation Division (SHPD) permit No. 0508.
Agencies	Hawai‘i DLNR, State Historic Preservation Division, (SHPD)
Land Jurisdiction	Private: The Eric A. Knudsen Trust, c/o Mr. Stacey Wong
Survey Acreage	8.633 acres.
Development Project Description	An archaeological inventory survey was conducted on an 8.633-acre area being considered for development by the Eric A. Knudsen Trust, on property adjacent to Hapa and Weliweli Roads, in Kōloa. The inventory survey was undertaken to determine if irrigation assets of the former Koloa Sugar Company were considered significant as historical artifacts of the plantation era in Kōloa.
Historic Preservation Regulatory Context	Cultural Surveys Hawai‘i, Inc., conducted this study in accord with HAR 13-276 and 13-284. The inventory survey and associated report were also prepared to satisfy SHPD requirements for archaeological inventory surveys in the State of Hawai‘i. Site significance assessments were made following the four categories of site significance evaluation (the National Register criteria for significance as outlined in the Code of Federal Regulations [36 CFR Part 60]), and a fifth Criterion E provided in the Hawaii Register of Historic Places and HAR 13-275-6 (Evaluation of Significance).
Field Effort	Fieldwork was accomplished by Todd Tulchin, B.S., Robert R. Hill, B.A., and Hallett H. Hammatt, Ph.D., August 02 through 04, 2005, and required 3 field-person-days to complete. Initial pedestrian survey was accomplished August 03, 2005, while subsurface testing, documentation, and photography was conducted August 03-04, 2005.

<table>
<tr><td>Sites Identified</td><td>There was one (1) historic property identified during the inventory survey.

Site 50-30-10-3926 represents a previously identified plantation-era elevated metal irrigation flume, which was constructed in 1902 by the Koloa Sugar Company.</td></tr>
<tr><td>Site Significance Evaluations</td><td>Significance evaluations for project area sites are based on criteria set forth in Section 6 .

<table>
<tr><th>State Site No.
(50-30-10-)</th><th>Function</th><th>Significance Criteria</th></tr>
<tr><td>3926</td><td>Agriculture</td><td>A, D</td></tr>
</table>
</td></tr>
<tr><td>Area of Potential Effect (APE)</td><td>The project’s APE extends no further than the proposed development footprint. The survey for the current investigation included the entire APE acreage.</td></tr>
<tr><td>Determination of Effect</td><td>The proposed development of the project area would impose an adverse effect on the existing historic property located within the project APE. The development of the subject property by the client is expected to require the destruction of the elevated irrigation flume (Site 50-30-10-3926). It is possible that additional subsurface historic properties may be located within the boundaries of the project area during excavation and grubbing activities.</td></tr>
<tr><td>Recommendations</td><td>The historic elevated irrigation flume, Site 50-30-10-3926, is an existing structure that runs through the middle of the project area. Sufficient information on this industrial artifact of the Koloa Sugar Company has been gathered and no further work is suggested. Based on the current survey, the following historic property located within the proposed development’s APE described above does not meet the significance criteria for inclusion within the Hawaii and National Register of Historic Places.

SHIP 50-30-10-3926</td></tr>
</table>

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Section 1 Introduction

1.1 Project Background

At the request of Mr. Stacey Wong, for the Eric A. Knudsen Trust, Cultural Surveys Hawaiʻi, Inc., (CSH) performed an archaeological inventory survey of an 8.633-acre parcel of the Eric A. Knudsen Trust Lands in Kōloa, Kauaʻi. The inventory survey was undertaken by the Eric A. Knudsen Trust in anticipation of the future development of property situated at TMK 4-2-8-014: 001 (*Mauka* portion). The development would result in the excavation, grading, and compaction of soils generally associated with the construction of a commercial property. The project area is located immediately *makai* (seaward) of Weliweli Road, and is bordered on the west by Hapa Road and on the east by other parcels whose present use appears to be pastureland. (Figure 1). The parcel extends south to other undeveloped pastureland parcels. The project parcel includes an elevated metal irrigation flume that was constructed to carry irrigation water across the property in a west-to-east direction. In addition to pastureland and the flume right-of-way, a small area within the project area is currently being used as a storage site for derelict construction equipment.

1.2 Scope of Work

The scope of work included:

1. A complete ground survey of the entire project area for the purpose of site inventory. All sites were located, described, and mapped with an evaluation of function, interrelationships, and significance. Documentation included photographs and scale drawings of selected sites and complexes.
2. Limited subsurface testing on subsurface deposits located within the project area. Subsurface deposits were excavated and analyzed for chronological and paleoenvironmental information.
3. Research on historic and archaeological background, including searches of historic maps, written records, and Land Commission Award documents. This research focused on the specific project area, with background on the district, the *ahupuaʻa*, and with special emphasis on settlement patterns.
4. The administrative rules of SHPD/DLNR also required consultation with community members about their cultural and historical concerns with the project area. CSH conducted a consultation from a list of knowledgeable *kamaʻaina* residents.
5. Preparation of a survey report that includes the following:
    a. A topographic map, if available, of the survey area showing all archaeological sites and site areas;
    b. Description of all archaeological sites with selected photographs, scale drawings, and discussions of function;
    c. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the archaeological features;
    d. A summary of cultural and historic issues resulting from community consultations.

e. A summary of site categories and their significance in an archaeological and historic context;

f. Recommendations based on all information generated that specify what steps should be taken to mitigate impact of development on archaeological resources- such as data recovery (excavation) and preservation of specific areas. These recommendations were developed in consultation with the client and the State agencies.

This scope of work also includes full coordination with the State Historic Preservation Division (SHPD), and County agencies relating to archaeological matters. This coordination only took place after the consent of the owner or representatives.

1.3 Environmental Setting

1.3.1 Natural Environment

Kōloa is a fairly large *ahupuaʻa* (9,500 acres), bounded on the east by Weliweli Ahupuaʻa, and on the west by Lāwaʻi Ahupuaʻa. The perennial Waikomo Stream traverses most of Kōloa Ahupuaʻa. The project area is approximately 0.60 miles (970 meters) southeast of the site of the Old Kōloa Mill (at Maulili) on the Waikomo Stream. The project area is bounded on its eastern side by the Weliweli Ahupuaʻa boundary line (Figure 2).

The elevation within the project area ranges from 160 ft (feet) to 180 ft above mean sea level (AMSL). The landform in this region of Kauaʻi is dominated by the broad, gently sloping pahoehoe lava flows of the post-erosional Koloa Volcanic Series, laid down in the late Pleistocene era. These lavas are little altered, but blanketed, in the inland portion, with a thin layer of Waikomo very rocky silty clay (Wt), a soil that "developed in material weathered from basic igneous rock," ash and cinder (Foote *et al*. 1972). These lands are further defined as, "well-drained, stony and rocky soils on uplands", and include small areas of Waikomo extremely rocky silty clay (Wu) and Fill Land (Fd) (Figure 3).

The plantation lands from Kōloa Village (west of the project area) to Pāʻā (east of the project area) were not utilized for the commercial cultivation of sugar. Instead, these lands surrounding Kōloa Village were set aside as pasture for the plantation pack animals (Figure 4). The lands also provided space for irrigation ditches and roads to connect Kōloa Village with Mill Camp, and the new mill in Pāʻā.

The project area receives an average of 55 inches (1400 millimeters) of rainfall per year, falling mostly in the winter months (November through March) (Giambelluca *et al.* 1986:86). Temperatures range from highs around 90ºF to maximum lows of about 50ºF, with the greatest variations occurring between day and night rather than winter and summer.

The vegetation of the project area consisted of a distinct plant succession sequence. In areas cleared with a bulldozer, with characteristic "push-piles" of boulders and cobbles and associated bulldozed paths through the long-standing vegetation, new growths of various grasses, such as Molasses grass (*Melinis minutiflora*) and California grass (*Brachiaria mutica*), occurred. In unmodified areas, the vegetation consisted of a moderately dense growth of *koa haole* (*Leucaena leucocephala*), Chinese Banyan (*Ficus bengalensis*), Pua-Be-Still (*Thevetia peruviana*), Century plants (*Agave sp.*), Sisal (*Agave sisalana*), and Java plum (*Syzygium cumini*).

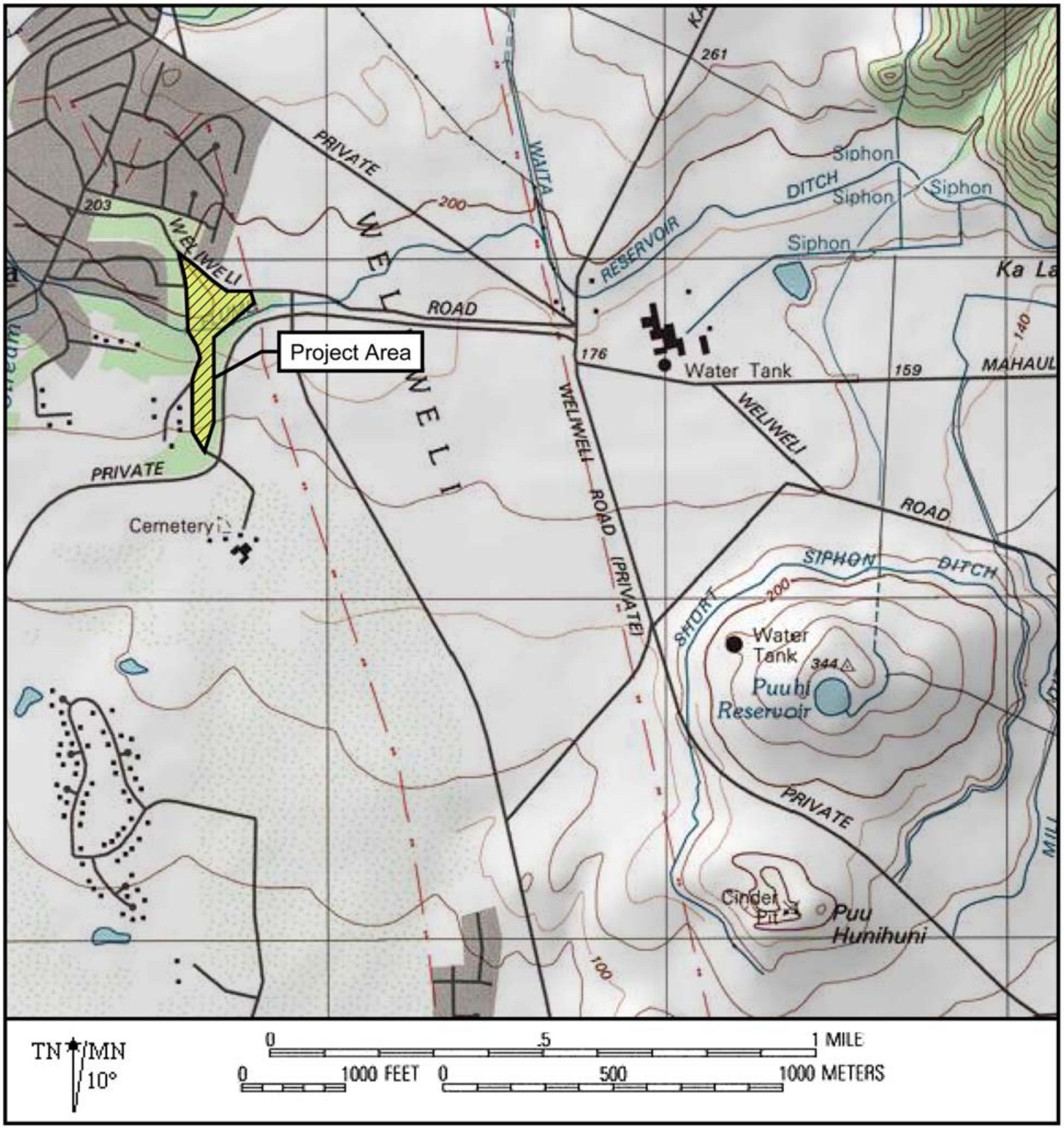


Figure 1. Portion of U.S. Geological Survey topographic 1:24000 map (1989), Kōloa Quadrangle, showing current Project Area shaded in yellow.

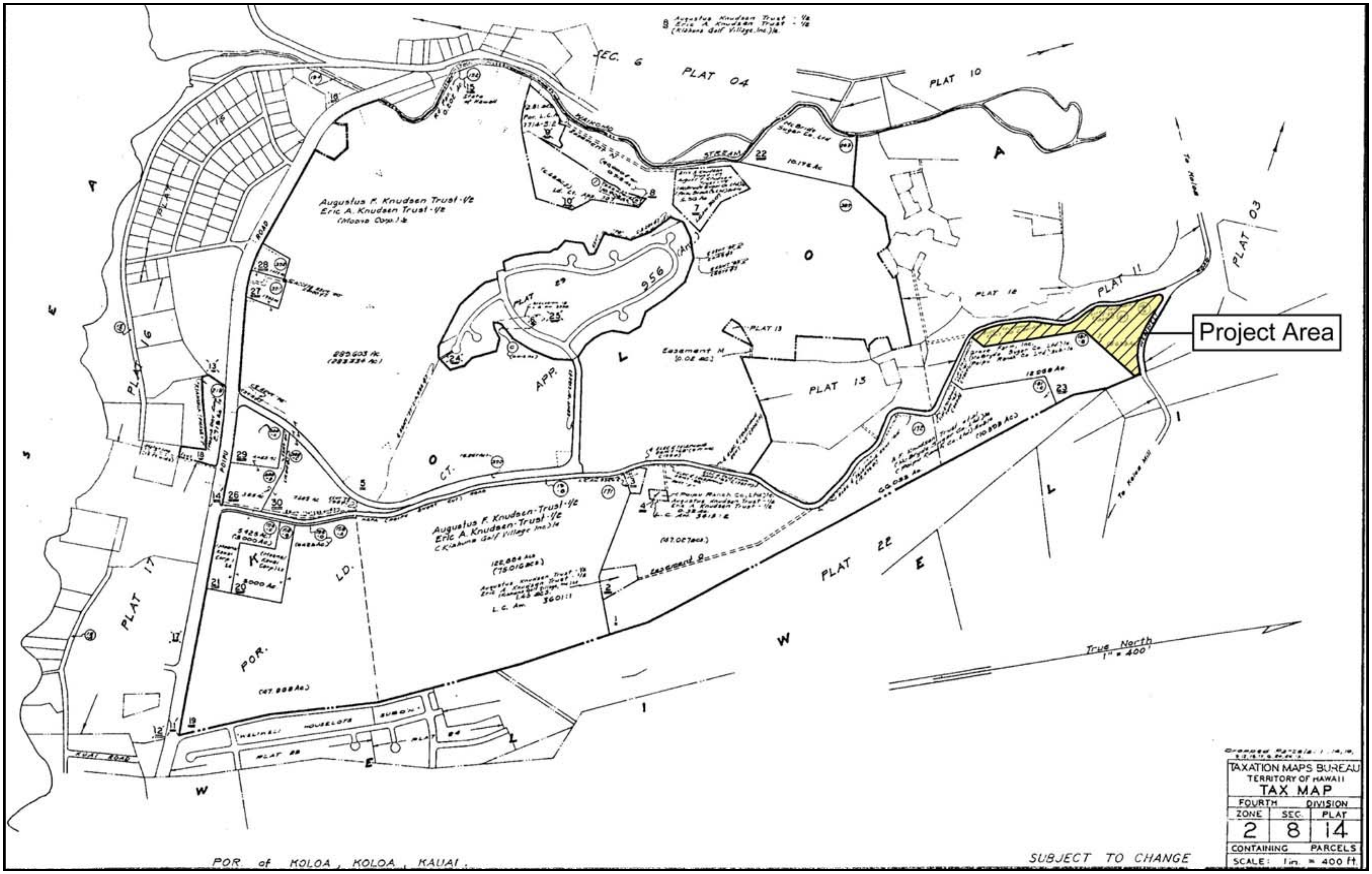


Figure 2. Portion of TMK: (4) 2-8-14 showing Project Area (shaded) at the intersection of Weliweli Road and Hapa Road. Note that the Kōloa Ahupua‘a / Weliweli Ahupua‘a Boundary borders the Project Area.

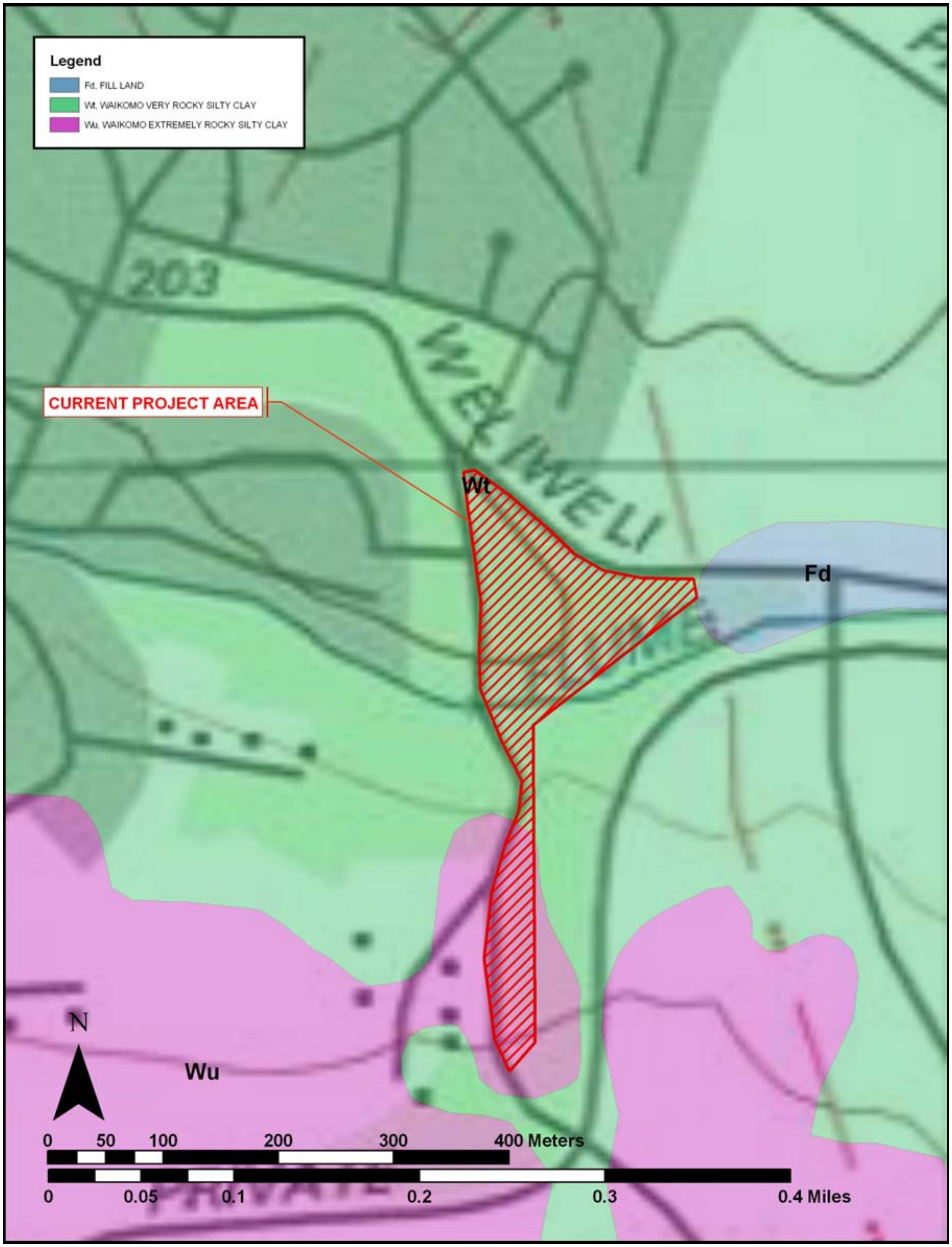


Figure 3. U.S. Geological Survey 7.5 minute series topographic map (1998), Kōloa Quadrangle, showing soil type distribution (USDA 2001) and Current Project Area (shaded).

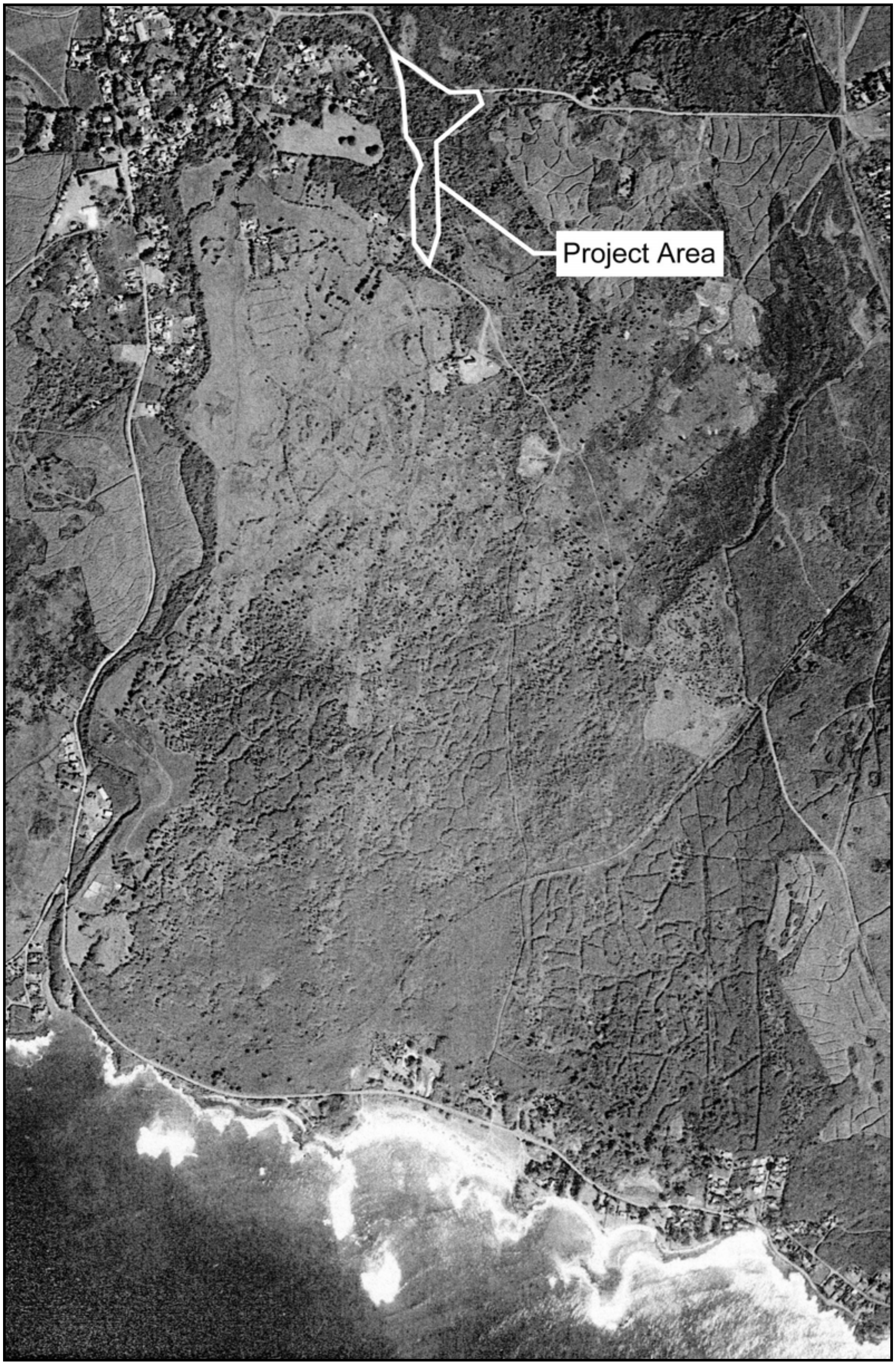


Figure 4. 1951 Aerial Photograph of the Kōloa Ahupuaʻa with the Project Area outlined.

1.3.2 Built Environment

The built environment of the project area consists of Weliweli Road: a paved 60-foot right-of-way on the northern property border. Hapa Road, that forms the western border, is a 45-foot paved right-of-way. The inventory survey area has been impacted by a significant amount of modification and alteration of the landscape during historic times by the sugar cane industry. A previously identified elevated metal irrigation flume (SIHP 50-30-10-3926) enters the western property boundary, crosses the subject property and exits the eastern property boundary bisecting the project area's northern half from its southern half. The flume was designed to connect to a concrete irrigation culvert at a point under Hapa Road.

Within the project area, some of the northern and western boundary areas have been bulldozed and cleared, with new grasses beginning to grow. Bulldozer paths and associated "push-piles" of boulders are found both north and south of the elevated metal irrigation flume feature. In an area immediately north of the flume, where it exits the project area at the eastern property boundary, a modern water trough built of concrete was in operation (Figure 5). The trough measured 70 cm tall by 1.5 m long, and was built one meter wide. The trough had been built from a poured form, and the aggregate within the concrete was modern. A ¾ inch lead pipe with a plunger valve supplied the water flow to the trough. The central part of the project area, containing the irrigation flume, is covered with moderately dense vegetation. The southernmost end of the project area contains derelict construction vehicles in a field divided by two barbed wire fence enclosures.

Figure 5. Modern concrete water trough located within the project area.

Section 2 Methods

Archaeological fieldwork was conducted by archaeologists Todd Tulchin, B.S., Robert R. Hill, B.A., and Principal Archaeologist Hallett Hammatt, Ph.D. The fieldwork was conducted from August 02 to 04, 2005.

2.1 Field Methods

The archaeological investigation consisted of a 100% surface survey and excavation of one test unit. The pedestrian inspection of the project area was accomplished through systematic sweeps oriented in a north to south direction at 10-meter intervals. The survey began in the southeast corner of the project area and moved to the north. All encountered sites were recorded and documented with a written site description, site maps, photographs, and GPS points using a Garmin GPS-5 unit for the project area. CSH-1 and CSH-2 were additionally recorded using GPS data supplied by a Trimble Pathfinder Pro XR.

Subsurface testing consisted of controlled excavation of one test unit (see Results of Fieldwork). Excavations followed natural strata with all excavated sediments screened through a 1/8-inch wire mesh screen. The soil stratigraphy was recorded; with soil attributes described using Munsell soil colors and U.S. Soil Conservation Service terminology. The completed test units were then photographed and backfilled.

2.2 Document Review

As part of the inventory survey, Jon Tulchin, A.S., performed a detailed review of all previous archaeological work conducted in the area. In addition, a variety of resources devoted to historical perspectives of the region and traditional stories and accounts were reviewed. Research venues included the State Historic Preservation Division of the Department of Land and Natural Resources, Hamilton Library at the University of Hawai‘i, the Hawai‘i State Archives, the Archives of the Bishop Museum, and the Survey Office of the Department of Accounting and General Services. All relevant Land Claim Awards (LCA) were inspected using resources associated with Waihona Aina, Corp. (Waihona Aina Corp., 2002).

2.3 Consultation

On September 20, 2005, a telephone interview was conducted with Ms. Stella Burgess, a resident of the Kōloa area, and the Hawaiian Cultural Specialist for the Hyatt Regency Kaua‘i Resort. Ms. Burgess has maintained her own research file of Royal Patents and Land Court Awards for *kuleanas* located within the Kōloa Ahupua‘a. In previous interviews regarding the land district of Kōloa, the origin of the *ahupua‘a* place name was discussed. She said the original name for the Kōloa District was actually “Kōloa Komohana”. This name literally meant that the land district was so vast, that Kōloa was a place, “Where one could see the sun rising in the east and setting in the west”.

Her research was able to confirm the location and extent of some upland features most closely associated with the ‘Kōloa Field System’. Before the commercial cultivation of sugar, the building of the railway, and the development of the shoreline, features common to the upland areas of the project parcel included traditional irrigation ditches (*‘auwai*), taro farming patches (*loʻi*), stone walls, and dry areas devoted to housing and dryland crops (*kula*). Traditional features common to the coastal areas of Kōloa included fishing huts and shrines, salt-drying ponds, in addition to the traditional farming features of the upland areas.

Ms. Burgess considered one of her most important accomplishments in maintaining her research files was her ability to preserve original Hawaiian place names. She discussed the origin of "Weliweli": the name for the *ahupuaʻa* directly east of Kōloa. The project area rests on the *ahupuaʻa* boundary of Weliweli, which had been named for a *menehune* chief. The *menehune* were a mythical race of small-statured people who were able to complete the construction of *heiau* (places of worship), fishponds, or irrigation ditches seemingly overnight.

Ms. Burgess spoke of the *menehune* chief Weliweli as having commanded his people to bring pohaku (stones) from the area known as Kaulala on the coast, in order that the rock would be properly set into walls in the upland areas of his domain. The story continues that the people were organized into long lines, and the rocks were passed from person to person over a distance of many miles, which resulted in many of the rock walls that one sees today criss-crossing the district.

Section 3 Background Research

3.1 Traditional and Historical Background

3.1.1 Mythological and Traditional Accounts

The project area is in the *ahupua‘a* of Kōloa in the Kona District on the island of Kaua‘i. Few records exist that document traditional Hawaiian life in the *ahupua‘a* of Kōloa. While settlement by westerners with religious and commercial interests made the area a focus of documentation after the first quarter of the 19th century, the accounts generally emphasized the lives and concerns of the westerners themselves, with only anecdotal references to the Hawaiian population. Two 19th century documents, the Boundary Commission Testimony of 1874 and a Lahainaluna manuscript of 1885, were able to provide an insight into the history of Kōloa before the arrival of westerners.

A dispute over the northern boundary of Kōloa Ahupua‘a in 1874 led to a hearing before Duncan McBryde, the Commissioner of Boundaries for Kaua‘i. One native witness, Nao (who described himself as born in Kōloa but presently living in Ha‘ikā), in order to show that Hoaea (the area in dispute) was indeed at the northern boundary of Kōloa, testified: "At Hoaea tea [*sic*] leaves were hung up to show that there were battles going on" (Boundary Commission, Kaua‘i, vol. 1, 1874:124). That there were traditional "warning systems"; well-known to all natives: suggests that Kōloa may well have been the scene of some serious conflicts. Throughout the early settlement history of Kōloa, conflicts must have occurred at intervals serious enough and often enough to warrant having to devise such a system.

Additional evidence of a rich history within Kōloa was offered in a Lahainaluna document produced eleven years later. This document appeared to have been based on an oral history project. On September 7, 1885 a student from Lahainaluna Schools (HMS 43 #17) interviewed Makea – "a native who is well acquainted with Kōloa" -- and recorded "what she said about the well-known places in the olden times." More than sixty-four years after the abolition of the *kapu* (taboo) system and almost as many years after contact with westerners, Makea was able to describe fourteen *heiau* (religious structures) within the Kōloa area. For example, she described the *heiau* of Maulili:

> Maulili was the first *heiau* of south Kōloa. Kapulauki was the first chief of Kōloa, Kiha came next. That is the chief I know of. He was a ruling chief of Kaua‘i in the olden days, when the *heiau* was standing there. It had already been built and men had been sacrificed on its altars. This Kiha was called Kiha-of-the-luxuriant-hair. Another name for him was Kakae and another was Ka-pueo-maka-walu [Right-eyed-owl].
>
> This *heiau* was also famous for this reason -- it was the first *heiau* to which Kawelo was carried after he had swooned in Wahiawa, in the battle where stones were used as missiles.
>
> The location of this *heiau* was not known, but a deaf mute knew and it was he who pointed it out to the chiefs, and that is how it was rediscovered in the olden days.

> Kiha lived on the eastern side of the *heiau* and Aikanaka lived on the northeastern side. This chief, Aikanaka, was the one with whom Kawelo fought and he was the owner of this *heiau* at that time.

There were several place names within Kōloa that have legendary associations. The name Kōloa itself has several derivations. Kōloa is the name for the large, soft Hawaiian sugar cane (*Saccharum officinarum*) once grown by the Hawaiians; Kōloa is also the name of a steep rock on the banks of Waikomo Stream, from whence the *ahupua‘a* got its name. This bank of the river was called Kōloa, after the native Hawaiian duck (*Anas wyvilliana*) (Kikuchi 1963:46; Pukui *et al*. 1974:116).

Maulili ([meaning] constant jealousy) is a deep pool in Waikomo Stream to the west of the present project area. When the gods Kāne and Kanaloa first came to Kaua‘i, legends say they explored the island and came to the pool at Maulili at evening. They stretched out beside the pool for their night's sleep on its eastern bank and left the impression of their forms within the rock: as can be seen in the ‘ā*papa* (a flat area). The Maulili *heiau* was first built by Ka-pueo-maka-walu, the son of Kapu-lau-kī. It was a place of human sacrifice (Wichman 1998:12). This *heiau* may be the Maulili *Heiau* described by Makea in the Lahainaluna document mentioned above. "The ‘*āpapa* in this vicinity is called an ‘*Unu*.' and a ‘*Heiau*,' but was never walled in, it is said. On the nights of Kāne, the drums are heard to beat there, also at the sacred rocks, or *unu's*, of Opuokahaku and Kanemilohae, near the beach of Poipu" (Farley 1907).

There are additional legends associated with the Maulili area.

> In the Maulili pool lived a large *mo‘o* [water spirit], named ‘Kihawahine'...The eastern wall of the pool, just below the resting places of Kāne and Kanaloa, for a short distance, only, is called the ‘Pali of Kōloa.' The District of Kōloa is named for this Pali, we are told by old Hawaiians. To the south of the Pali o Kōloa, in the wall is a rock named ‘Waihānau' ([meaning] birth water)...as one of their *mele*s has it:
>
> *Aloha wale ka Pali o Kōloa,*
> *Ke Ala huli i Waihānau e, hānau.*
>
> To the south of Waihānau is a projecting rock named ‘*Ke elelo o ka Hawai‘i*' -- the tongue of Hawai‘i, said to have been wrested and brought from Hawai‘i by the Kaua‘i warrior Kawelo, of Wailua. At the southern end of the Maulili pool started two large *‘auwai*'s [irrigation ditches], that watered the land east and west of Kōloa (*ibid* 1907:93).

In this way, the early inhabitants of the region venerated the spirits that gave life to the lowland taro patches of Kōloa. While taro would have been essential to the life of the *ahupua‘a*, other agricultural niches were nurtured in order that harvests could be increased. Bernice Judd, writing in 1935, summarized most of what was known of the traditional Hawaiian life of Kōloa:

> In the old days two large *‘auwai* or ditches left the southern end of the Maulili pool to supply the taro patches to the east and west. On the *kuāuna*s [embankments] the natives grew bananas and sugar cane for convenience in irrigating. Along the coast they had fish ponds and salt pans, ruins of which are still to be seen. Their dry land farming was done on the *kula* (dry land), where they raised sweet potatoes, of which both the tubers and the

> leaves were good to eat. The Hawaiians planted *pia* (arrowroot) as well as *wauke* (paper mulberry) in patches in the hills wherever they would grow naturally with but little cultivation. In the uplands they also gathered the leaves of the *hala* (screwpine) for mats and the nuts of the *kukui* (candlenut) for light (Judd 1935:53).

Beginning possibly as early as 1450, the ‘Kōloa Field System’ was planned and built on the shallow lava soils to the east and west of Waikomo Stream. The Kōloa Field System is characterized as a network of fields of both irrigated and dryland crops, built mainly upon one stream system. Waikomo Stream was adapted into an inverted tree model with smaller branches leading off larger branches. The associated dispersed housing and field shelters were located among the fields, particularly at junctions of the irrigation ditches (‘*auwai*). In this way, the whole of the field system was contained within the entire *makai* (seaward) portion of the *ahupua‘a* of Kōloa stretching east and west to the *ahupua‘a* boundaries.

The field system, with associated clusters of permanent extended family habitations, was in place by the middle of the 16th century and was certainly expanded and intensified continuously from that time. Long *‘auwai* were constructed along the tops of topographic high points formed by northeast to southwest oriented Kōloa lava flows. These *‘auwai* extended all the way to the sea. Habitation sites, including small house platforms, enclosures and L-shaped shelters were built in rocky bluff areas which occupied high points in the landscape and were therefore close to *‘auwai*, which typically ran along the side of these bluffs (Hammatt et al 2004). From A.D. 1650-1795, the Hawaiian Islands were typified by the development of large communal residences, religious structures and an intensification of agriculture. Large *heiau* in Kōloa may date to this period.

The manufacture of salt was important for the Native Hawaiians. Many of the larger salt pans on Kaua‘i are located near Nōmilu, “where people came in the summer to gather salt when the winds blow the salt across the surface of the pond at the edge of the pond where it was carefully scooped out with the hands or with pieces of gourd shell and dried” (Wichman 1998:35). The importance of salt manufacture in the area was illustrated in the 1874 Boundary Commission determination for Kōloa, where the oral testimony of Pene Kalauau claimed he came all the way “from Koolau to go to Koloa for salt” (Boundary Commission, 1874, Kauai, Vol. No. 1:124).

The coastal portion *makai* (seaward) of the project area consisted of several curved sandy beaches between rocky promontories. Two of these rocky points, or *lae*, on each side of the present location of the Sheraton Kaua‘i Resort, were named Lae o Ka‘ōpua and Lae o Kamilo. No ethnographic sources for the meanings of these names could be found for these areas in Kaua‘i. However, there is a point on the island of Hawai‘i called “Lae o Kamilo”, which is interpreted as “the twisting of ocean currents”, or a place where driftwood would pile up on the shore (Pukui *et al*. 1989:127).

The god Kāne was also associated with the shoreline of Kōloa. On the nights of Kāne, drums are heard at the ‘*unu*, or sacred rocks, at Maulili pool, and also at ‘*unu's*, of Opuokahaku and *Kānemilohae*, near the beach of Po‘ipū (Farley 1907). In 1961, William Kikuchi conducted a survey of Kaua‘i. He identified one site along the coast (Site 89) as *Kāne-milo-hai*, which consisted of several walls on a pahoehoe ridge, and two brackish water ponds on both sides of the ridge with walls within them. (Kikuchi 1963:66).

There are other accounts of the beating of drums along the Kōloa coast. A shrine on the beach was dedicated to Kūhaimona, the shark god. On the night of Kāne each month, a drum was beaten to proclaim a *kapu*. No one was allowed on the beach that night, since Kūhaimoana and the other shark gods came up to the beach and took spiritual possessions of their keepers. Anyone breaking the k*apu* would become food for the shark gods (Wichman 1998:43).

In 1963, Mr. And Mrs. Moir reported that they were sitting on the *lānai* of their house (now part of Moir’s Cactus Garden) in the early evening and heard what sounded to be drums coming from the direction of a former *heiau* on the beach. This *heiau* was said to be a fertility *heiau* where women went.

3.1.2 Early Historic Period

Accounts by visitors and settlers at Kōloa Ahupua‘a focused on the early westerners’ own concerns--religious and commercial--as these concerns appeared within the historical record of Kōloa in the 1800's. However, scattered throughout the accounts are occasional references to the Hawaiians of the *ahupua‘a* that may give some insights into their lives.

The American Board of Commissioners for Foreign Missions (ABCFM) missionary Samuel Whitney described, in an article in the *Missionary Herald* (June 1827:12), a visit to Kōloa with Kaikio‘ewa, the governor of Kaua‘i, in 1826:

> The people of this place were collected in front of the house where the old chief lodged in order to hear his instructions. After a ceremony of shaking hands with men, women, and children they retired...
>
> Our company consisted of more than a hundred persons of all ranks. The wife of the chief, with her train of female attendants, went before. The governor, seated on a large white mule with a Spaniard to lead him, and myself by his side, followed next. A large company of *aipupu*, [*‘ā‘īpu‘upu‘u*] cooks, attendants came on in the rear.

Whitney's account suggests something of the deference paid to the *ali‘i* (chiefs) by the local populations and the scale at which the *ali‘i* carried out their functions. An even grander view of that deference was provided in an account of a later visit by an *ali‘i* to Kōloa. John Townsend, a naturalist staying in Kōloa in 1834, described a visit by Kamehameha III (In Palama and Stauder 1973:18):

> In the afternoon, the natives from all parts of the island began to flock to the king's temporary residence. The petty chiefs, and head men of the villages, were mounted upon all sorts of horses from the high-headed and high-mettled California steed, to the shaggy and diminutive poney [sic] raised on their natives hills; men, women, and children were running on foot, laden with pigs, calabashes of *Poe* [sic], and every production of the soil; and though last certainly not least, in the evening there came the troops of the island, with fife and drum, and 'tinkling cymbal' to form a body guard for his majesty, the king. Little houses were put up all around the vicinity, and thatched in an incredibly short space of time, and when Mr. Nuttall, and myself visited the royal mansion, after nightfall, we found the whole neighborhood metamorphosed; a beautiful little village had

> sprung up as by magic, and the retired studio of the naturalists had been transformed into a royal banquet hall.

In 1835, Thomas Nuttall and John K. Townsend, two American naturalists, visited the Kōloa area. They noted "fields of taro, yam, and maize (possibly sugar cane), irrigation networks and sweet potato patches in the dryer areas." (Townsend 1839:206)

On December 31, 1834, Peter Gulick and his family arrived in Kōloa. Apparently the first foreigners to settle in the *ahupuaʻa,* they initiated the process of rapid change that would re-shape the life of Kōloa in the nineteenth century. In 1835, a 30 by 60 foot grass house was erected as a meeting-house and school near the Maulili Pond. Mr. Gulick cultivated sugar cane and collected a cattle herd for the Protestant Mission. In 1837, a 45 by 90 ft. adobe church was built where Kōloa Church stands today, and the first mission doctor, Thomas Lafon, arrived to assist Mr. Gulick (Damon 1931:179, 187). The Kōloa mission station apparently flourished immediately. Navy Lieutenant Charles Wilkes, a member of the U.S. Exploring Expedition, during his visit to Kōloa in 1840, recorded:

> The population in 1840, was one thousand three hundred and forty-eight. There is a church with one hundred and twenty-six members, but no schools. The teachers set apart for this service were employed by the chiefs, who frequently make use of them to keep their accounts, gather in their taxes &c. The population is here again increasing partly by immigration, whence it was difficult to ascertain its ratio (Wilkes 1845:64).

Other sources, however, give different population figures for Kōloa during the first half of the nineteenth century. In 1834, according to a report by missionaries on Kauaʻi, the inhabitants of the *ahupuaʻa* numbered 2,166 (*Kauai answers*…1833, cited in Palama and Stauder 1973:16; also found in the newspaper, *Garden Island* July, 27, 1935). However, in this census, Kōloa was used to refer to the whole area between Wahiawa and Kalapaki. An article in the *Pacific Commercial Advertiser* of December 21, 1867 estimated that the population in 1838 was about 3,000. By 1867, it had been reduced to a third of that number. James Jackson Jarves, who visited Kōloa and Kauaʻi for nine months during the early 1840's, recorded:

> Kōloa is now a flourishing village. A number of neat cottages, prettily situated amid shrubbery have sprung up, within two years past. The population of the place, also, has been constantly increasing, by emigration from other parts of the island. It numbers, now, about two thousand people, including many foreigners, among whom are stationed a missionary preacher, and physician, with their families (Jarves 1844:100).

The arrival of many foreigners was the cause of, and the native emigration to Kōloa was the result of, the many commercial activities that burgeoned beginning in the 1830's. In 1835, Ladd and Company leased from the king and local chiefs about one thousand acres at Kōloa for 50 years at $300 a year and were "allowed the use of the waterfall and an adjoining mill site at Maulili pool, not far from the thousand acres, together with the right to build roads, the privilege of unrestricted buying and selling and freedom from local harbor dues" (Judd, 1935:57).

Ladd and Company was not the first venture to mill sugar cane in the area. There had been a Chinese-operated granite roller mill in operation at Māhāʻulepū, Kōloa, in 1830. Water buffalos had been imported as power for the grinding stones. To Ladd and Company goes the distinction of operating the first plantation-organized industry in Hawai‘i (Damon, 1931:176, 198). Their original 12-acre sugar field was cultivated in 1835, the same year Ladd and Company was incorporated as a sugar enterprise (Gilmore 1936). The first mill was located at Maulili on the Waikomo Stream, employed wooden Koa rollers to crush the stalks, and whaling try-pots to boil the juice. This arrangement only produced 100 barrels of molasses. The next year a new dam was built just downstream, iron rollers and copper boiling pans were installed in a new mill, and 30 tons of sugar, and 170 barrels of molasses resulted (Donohugh 2001).

Labor was the plantation’s most serious problem. Of this, Judd notes the following:

> The company was permitted to hire natives to work on the plantation provided they paid Kauikeaouli, the king, and Kaikio‘ewa, the governor of Kaua‘i, a tax for each man employed and paid the men satisfactory wages. The workers were to be exempt from all taxation except the tax paid by their employers (Judd 1935:57).

Judd further described the revolutionary implication of this arrangement: "The significance of Ladd and Company's lease lay in the fact that it was the first public admission by the Hawaiian chiefs that their subjects had rights of personal property backed with a guaranty of protection to that property" (Judd 1935:58). Local chiefs, fearful of a usurpation of their power, resisted the company's first efforts to recruit workers, forcing the king's intervention.

Because land titles could not be purchased, the procurement of tools for the production of sugar was difficult. Labor troubles consisted of local taboos forbidding work on certain days. Crude evaporation methods resulted in sugars of inferior quality. Although the Chinese mill and Ladd’s first mill had been established and abandoned at Kōloa prior to 1840, a third was built in 1841. Ladd and Company demonstrated that an investment in an organized plantation could produce impressive results. Thomas Thrum gives the production for 1838 as 5,039 pounds of sugar and 400 gallons of molasses. Managers with greater experience in the production of sugar were hired, and the quality of the product from Kaua‘i was improved (Wadsworth 1936).

Kōloa Village and Kōloa Landing, at the mouth of the Waikomo Stream, became flourishing commercial centers because of these new agricultural initiatives. “An estimate in 1857 stated that 10,000 barrels of sweet potatoes were grown each year at Kōloa, and that the crop furnished nearly all the potatoes sent to California from Hawai‘i. Sugar and molasses were also chief articles of export” (Judd 1935:326). Whalers used the Kōloa “Roadstead” from 1830 to 1870, and took on provisions of squashes (pumpkins), salt beef, pigs, and cattle (Damon 1931:176). Hawaiians grew the pumpkins on the rocky land north of the landing. There were also numerous salt pans along the shore near the landing that were used to make the salt (Palama and Stauder 1973:20).

3.1.3 Mid-1800s and the Great Māhele

In the early Post-Contact period, the *ahupua'a* of Kōloa was controlled by the ruling chief of Kaua'i and was administered by lesser chiefs appointed by him. When Ka-umu-ali-i, last of the ruling chiefs of the island, died in 1824, his lands (Kaua'i and Ni'ihau) were given to the lineal descendants of Kamehameha. Queen Ka'ahumanu redistributed the lands among chiefs of other islands who had been loyal to the bloodline of Kamehameha. By the mid-19th century, control of the *ahupua'a* of Kōloa was divided between Kamehameha III and Moses Kekūāiwa, a brother of Kamehameha IV (Alexander 1984). The Māhele Award records indicate that Kōloa Ahupua'a, which totaled 8,620 acres, was awarded (LCA 7714-B) to Moses Kekūāiwa, (the brother of Alexander Liholiho [Kamehameha IV]), Lot Kapuāiwa (Kamehameha V), and Victoria Kamāmalu.

Land Commission Awards (LCA's) were granted by ministers representing the Kingdom of Hawaii's Department of the Interior. Testimony to establish title to real property was recorded by Native Register -wherein claimants would provide traditional proof of ownership- and by Foreign Register -wherein boundary survey evidence would support traditional claims.

One award, granted adjacent to the Mainui portion of Kōloa, in the *'ili* (a subdivision of an *ahupua'a*) of Kauwaeluna, not only illustrates a typical '*āpana* (land parcel) for the upland Kōloa area, but was located within the boundary of the current project area.

Lehukini claimed and was awarded one '*āpana* in LCA 3267. A portion of the '*āpana* was located within the present project area. In the Māhele Award documents, the '*āpana* was described as containing a *lo'i* (taro patch) and a *kula* (dry planting area). The 'āpana was located in the '*ili* of Kahuwaeluna, which was bounded thus:

> [Bounded] *mauka* [toward the mountain] by the *kula* [dry land]of Mainui;
>
> [Bounded] *Puna* [east] by the '*ili* [land subdivision] of Keaku;
>
> [Bounded] *makai* [seaward] by my land;
>
> [Bounded] *Hanapepe* [west] by '*auwai* [irrigation ditch]and Mainui's land.
>
> (Native Register vol.9, pg. 22-23)

Lehukini claimed that he, "received this land from Hukiku in the days of Kinau". The '*ili* of Keaku referred to in the above land description includes land within the present project area.

In addition to the above-referenced LCA within the present project area, two LCAs were granted adjacent to the present project area, both of which were granted to two separate individuals just west of the project area. All three of these Land Commission Awards are shown on the 1891 Kingdom of Hawaii Government Survey map of surveyor M.D. Monsarrat. (Figure 6) In addition, the map shows approximately 35 LCA's located on the outskirts of Kōloa Village proper. Cane lands, irrigation ditches, and stone walls are located immediately west of the project area boundary on the Monsarrat map, which also shows a road passing directly north-south through the project area. The land areas of LCA 3267 (to Lehukini), LCA 3311 (to Mainui) and LCA 6309 (to Kapuniai) appear to have shared a common irrigation ditch.

The terms of LCA 3311 transferred a section of the *ili* of Kahuwaeluna to the claimant "Mainui" using traditional boundary descriptions. An amount of "kula" land, six taro patches, a house lot, and a cane field were claimed as land features appurtenant to LCA 3311.

The terms of LCA 6309 transferred a section of the ʻ*ili* of Hakeku to the claimant "Elia Kapuniai" using traditional boundary descriptions. A house lot and a stone wall were claimed as land features appurtenant to LCA 6309.

Eighty-eight other *kuleana* awards were given to individuals within Kōloa Ahupuaʻa. The majority of these Land Commission Awards were located in and around Kōloa Town itself. The largest award went to the Protestant Mission of Kōloa (LCA 387), which consisted of 825 acres of property located just southwest of the center of Kōloa Town. On this property, the church and parsonage were built, cattle were grazed and sugar was cultivated (Waihona Aina Corp. 2002).

The cane growing activities of Ladd and Company had affected the lives of the inhabitants of the rest of the *ahupuaʻa* and changed traditional settlement patterns. Prior to the commercial cultivation of sugar, permanent and temporary habitation was interspersed throughout the irrigated agricultural fields near the coastal zone and occurred adjacent to traditional farms established along streams. Settlement patterns shifted to the town of Kōloa, where opportunities at the sugar cane mill existed. The corresponding shift toward the mechanization of agriculture was inevitable. The hand-cultivation of taro patches and the hand-preparation of *poi* fell to those who did not take jobs with the sugar enterprise

An early pioneer of the sugar industry on Kauaʻi was Valdemar Knudsen. As the son of Knud Knudsen, then President of Norway, Valdemar Knudsen sought his fortune in the United States. He established a successful trading company in California during the gold rush in 1849, but relocated to Hawaiʻi for health reasons in 1853. He became manager of the Grove Farm Plantation in Lihue for the Wilcox family, purchased and developed lands along the Kōloa coast, and acquired businesses in Kekaha and Mana (Hawaiian Sugar Planters Association 1926).

By the early 1800's, Kōloa Landing had become the principal port of Kauaʻi. Shipments of North American furs and pelts to the Orient depended on the provisioning of ships at Kōloa Landing, as well as other Hawaiian ports. As the fur trade grew, markets in China became aware of sandalwood (*Santalum sp.*) grown in the Hawaiian Islands. The shipment of most of Kauaʻi's sandalwood to the Orient took place at Kōloa Landing, until the supply of the fragrant wood was exhausted around 1830.

Although Ladd and Company ended sugar operations in 1845, its earlier success was an impetus for other entrepreneurial attempts within Kōloa. Silkworm farming, oil extraction from *kukui* nuts, cigar manufacturing, sago raising, and tapioca manufacturing were all attempted with varied success during the middle third of the nineteenth century. The Great Māhele of 1848, with its promise of surety of land titles, should have stimulated the production of sugar; however, a period of low prices, coupled with a drought in 1851, drove many of the smaller enterprises out of business. By 1854, The Koloa Sugar Company had acquired all of the sugar interests of Ladd and Company, and had erected a new, more modern sugar mill (Gilmore 1936).

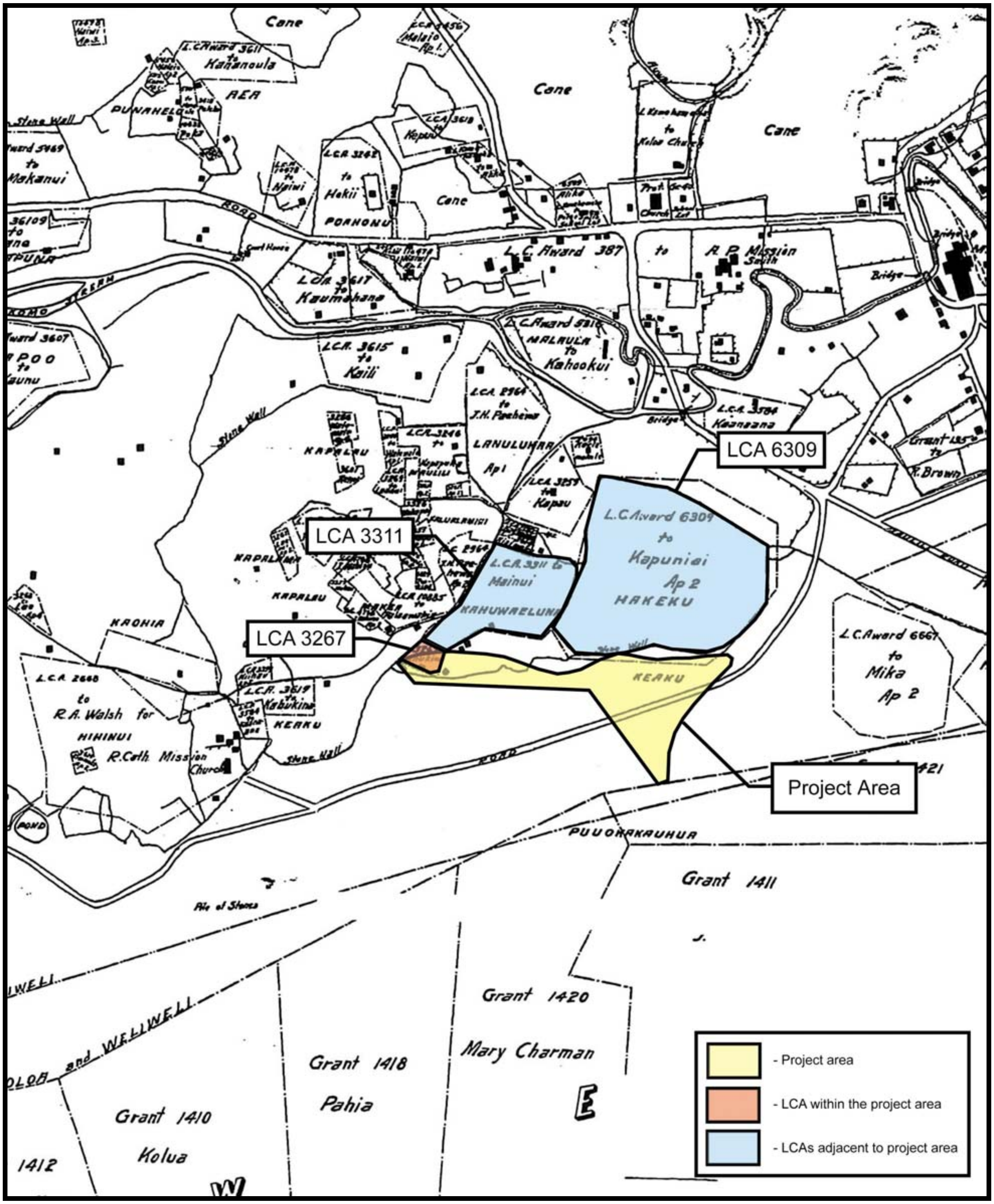


Figure 6. Government Survey Map of Kōloa Landing showing LCAs proximate to Project Area (adapted from Monsarrat 1891).

The Koloa plantation's sugar crop of 1854 yielded 300 tons of sugar, which was sold for $150 per ton. 450 acres of Kolōa land was under cultivation, and development of additional acreage continued gradually until the annexation of the Hawaiian Islands by the United States in 1898. The structure of government, which had recently changed from a Monarchy to that of a Republic in 1893, had, in the eyes of businessmen and investors, become a more stable government. By 1900, cane lands harvested annually by the Koloa Sugar Company had doubled to 950 acres, and had doubled again to 2,040 acres by 1920. By 1935, over 4,000 acres of Koloa Sugar Company lands were in cultivation, which resulted in average annual harvests of over 2,600 acres (Gilmore 1936).

The Koloa Boarding School for Girls was established in 1861 by Mrs. Milicent Knapp Smith. The American Board of Commissioners for Foreign Missions sent James William Smith, M.D., and his wife to the Kōloa station in 1842. James Smith became the second permanent doctor at Kōloa station, and remained there until his death in 1887. Millicent Knapp Smith died in Kōloa in 1891. The Kōloa station had been established in 1834, and was able to maintain a strong influence in Kōloa throughout the years of turmoil associated with fur trading, sandalwood, and whaling (Donohugh 2001).

Another major area of commercial enterprise was associated with the whaling industry at Kōloa Landing, whose peak years ran from the 1830's to the 1860s. Accounts of visitors suggest that the inhabitants of Kōloa took advantage of their proximity to Kōloa Landing to participate in the booming trade of the port. An article in the *Pacific Commercial Advertiser* of Feb. 19, 1857 described the significant characteristics of the port at mid-century and mentions:

> From the landing there is a good carriage road to the town, distant about two miles. Large quantities of firewood, bullocks and sweet potatoes are furnished to whalers in this port, and these chattels can nowhere be procured cheaper or better. It is estimated that 10,000 barrels of sweet potatoes are cultivated annually here, which are thought to be the best on the islands. Nearly all the potatoes furnished for the California market are produced here...Sweet potatoes, sugar and molasses constitute the chief trade of the port.

In 1852, the Royal Hawaiian Agricultural Society sought laborers from China during the expansion of the plantation at Kōloa. With an increase in cultivated areas to 450 acres, and the construction of a new mill in 1854, manpower requirements had not been met locally. In December, 1859, the American schooner "Wamp" arrived at Kōloa Landing with ten South Sea Islanders who hired themselves out to the plantation. Although foreign emigration during the period prior to the American Civil War was limited, conditions would soon change (Thrum 1901).

Through the recommendation of King Kamehameha V, a bill was passed in 1864 that created a Bureau of Immigration. In 1868, the Hawaiian consul in Japan arranged for the transportation of 148 Japanese laborers to Hawai'i on the ship "Scioto". By 1876, the adoption of the Treaty of Reciprocity with the United States assured plantation owners that the importation of large numbers of foreign workers would be crucial for the development of Hawaii's sugar industry. The chartered ship "Priscilla" brought 180 Portuguese from Madeira and the Azores to Hawai'i in 1878; merely the vanguard of the thousands of Spanish, Russians, Koreans, Filipinos, Puerto Ricans, Scandinavians, Germans, Galicians, Americans, Chinese, South Sea Islanders and Portuguese yet to arrive (H.S.P.A. 1926).

In 1882, The Koloa Sugar Company announced it had ordered all the components for a plantation railroad. According to the *Planter's Monthly*, Vol. 1 of 1882, "It will consist of four miles of 30 inch gauge track, forty cars 5 x 10 feet, and one locomotive" (Conde 1993: 28). According to Arthur C. Alexander, in *Koloa Plantation 1835-1935*, "Cut cane was hauled to the mill by oxcart until 1882. In that year, 3½ miles of 30-inch gauge, 18 pound railroad track and 50 cars were purchased"(Conde 1993: 28).

The Koloa Sugar Company added additional permanent track to cultivate Māhāʻulepū Valley in 1887. By 1885, the rails extended to Kōloa Landing where the steamers transported the bags of sugar to the mainland. By 1895, the branch line of the railroad to Kōloa Landing was renovated by adding a short spur line along the eastern side of the landing so trains could back cars onto it for easy unloading of bagged sugar and loading of supplies (Donohugh 2001). A motorized derrick winched the bagged sugar from the railroad cars to the warehouse on the west side of the landing. From there, bagged sugar was loaded onto small lighters, which would row the sugar out to waiting ships in the harbor.

In 1910, the *San Francisco Chronicle* commented:

> Cane is transported from the fields to the mill over a railroad system that consists of fifteen miles of permanent track, two miles of portable track, 250 cane cars and four locomotives. About two miles from the mill and connected with by rail is the steamer landing, with a warehouse that will hold 20,000 bags of sugar (cited in Conde and Best 1973:159).

An examination of the Territorial Planning Board maps dated 1939 (as adapted from the U.S. Geological Survey) produced a Koloa Village map (See Figure 7). The railroad connected Kōloa Village to Puʻu-o-hewa Reservoir in the north, Kōloa Landing to the south, the new mill at Pāʻā (Figure 8) to the east, continuing five miles further east to the Māhāʻulepu Pumphouse. The path of the elevated metal irrigation flume within the present project area is shown southeast of the village.

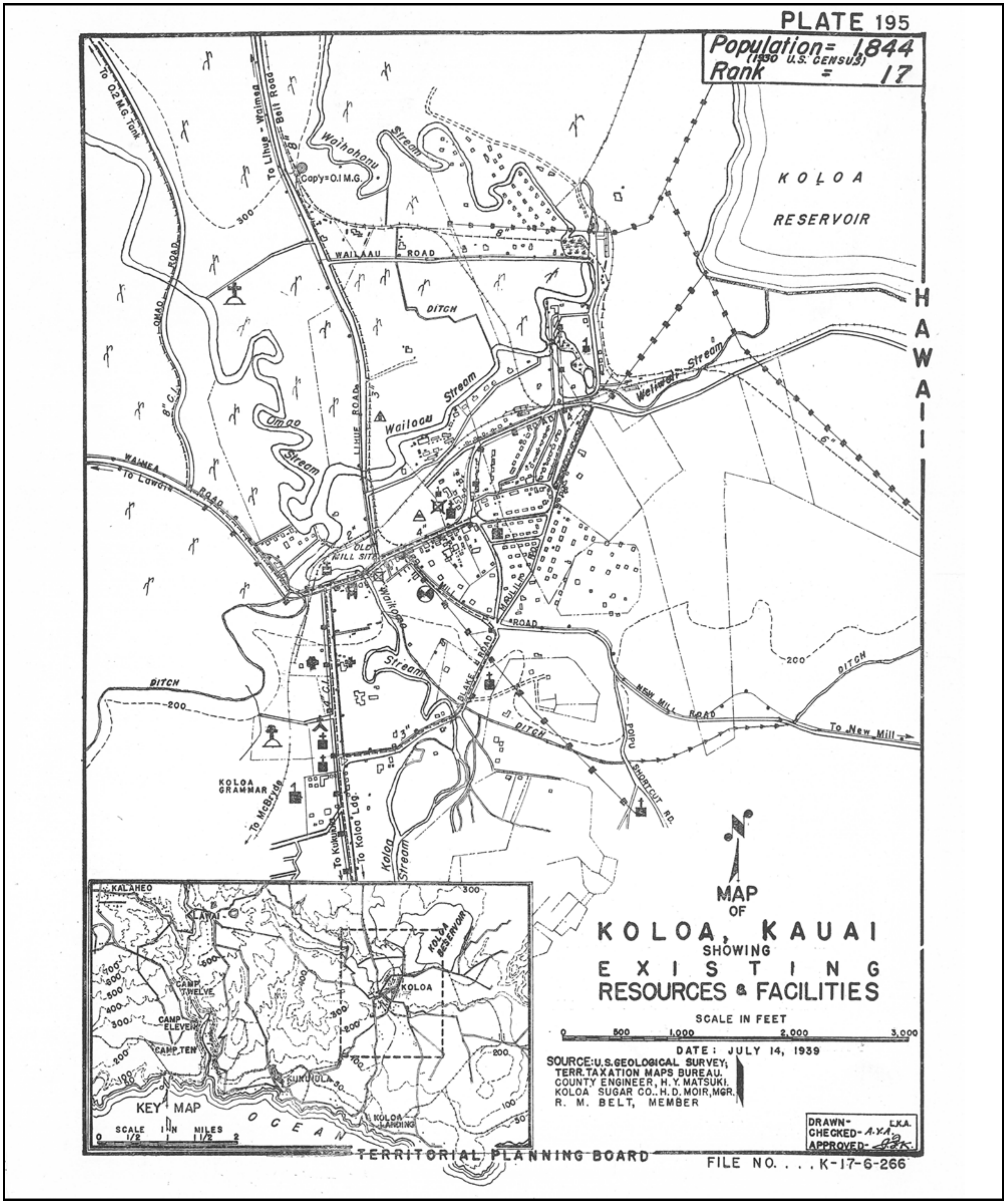


Figure 7. Resources and Facilities Map of Kōloa, Kaua'i. Note the path of the elevated flume between "Poipu Shortcut Road" and "New Mill Road". The first 100 meters of the flume east of the "Poipu Shortcut Road" are within the project area.

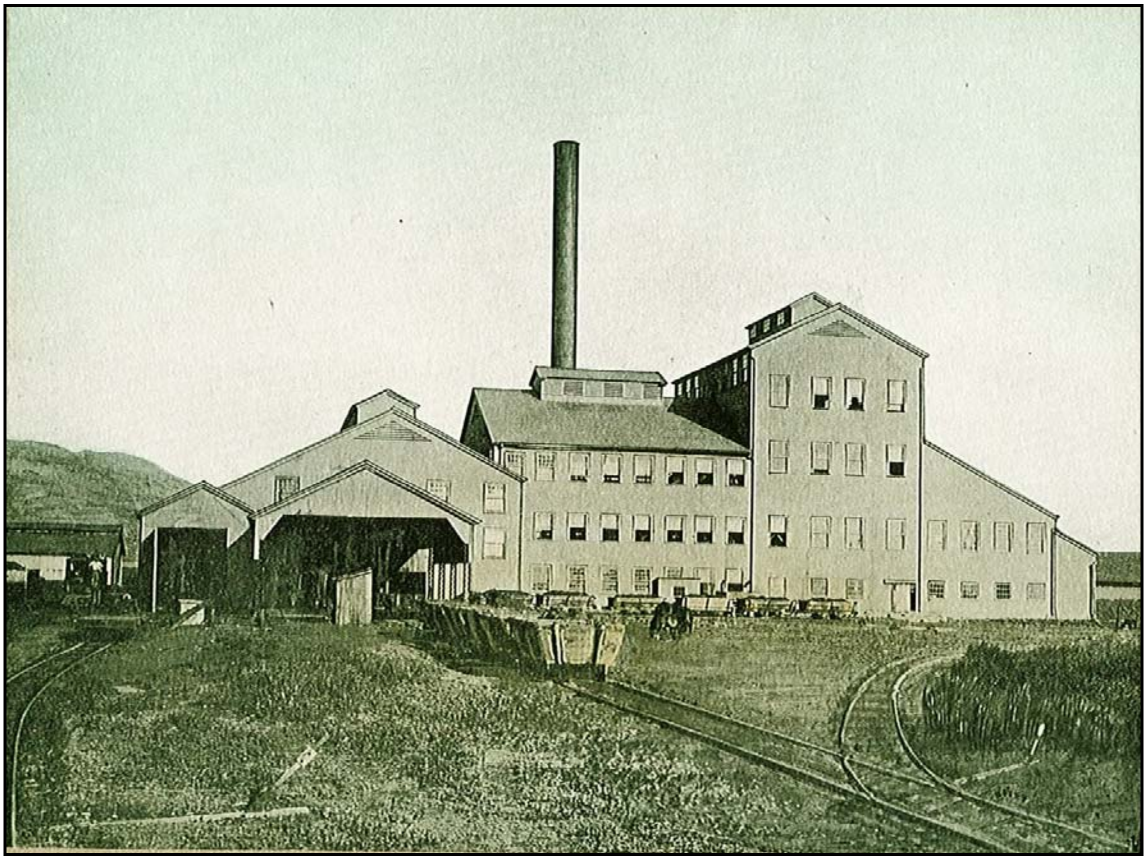


Figure 8. The mill of the Kōloa Sugar Company circa 1924 (adapted from Honolulu Iron Works 1924:50)

3.1.4 1900's

The Koloa Sugar Company had previously purchased the *ahupua‘a* of Pā‘ā southeast of the town, and a large parcel of it was unproductive. A new and much larger mill was built there in 1912 about a mile from Kōloa (Figure 9). New railroad track was laid, and an asphalt road was built to connect the new mill with Kōloa Landing. World War I caused a huge demand for sugar. By the end of hostilities in 1918, The Koloa Sugar Company was producing 9,000 tons of sugar each year, and adding additional acreage.

Kōloa Landing was phased out around 1925 when McBryde Sugar Company and The Koloa Sugar Company began shipping their product out of Port Allen Harbor at Hanapēpē. The McBryde Plantation had been improving the facilities at Ele‘ele Landing since the turn of the century, and a private company, The Kauai Terminal Limited Railway, had developed a modern bridge crossing the Hanapēpē River. Soon after this, the Koloa Sugar Company ceased to use the *makai* (seaward) Kōloa fields, and much of the area was converted into cattle-grazing pasture by the Knudsen family. Most of the *mauka* (upland) areas of Kōloa remained under sugar cane cultivation as late as the 1970s, when these cane lands were converted into pasture.

Steam powered plows, which had replaced animal teams in the fields in the 1890's, had been replaced by tractors by the 1920's. The plantation railroad, which continued to carry sugar and workers throughout World War II, was dismantled in 1947. In 1948, Grove Farm Company bought the Koloa Sugar Company. These two adjacent plantations were separated by a mountain range, so the construction of a half-mile-long vehicular tunnel through the mountain resulted in a true operational merger of the two plantations. Although all railroading within the Kōloa Division of Grove Farm had been replaced by trucking, the Haiku Division was still operating about 1/3rd of their railway into 1954.

In 1952, the first large hotel on the Kōloa Coast, the Wai‘ohai Hotel, opened near Po‘ipū Beach. Construction of the Sheraton Kaua‘i Resort began in 1967. Adjacent to the east side of the Sheraton Kaua‘i Resort is the Plantation Gardens Restaurant, a structure that was built by Eric A. Knudsen in 1930. He gave the house as a wedding present to his daughter, Alexandra (Sandie) Knudsen and her husband, Hector Moir, who became the manager of the Kōloa Plantation in 1933. The cactus garden was begun by Sandie Moir as a hobby, but by 1948, had become a world-class cactus garden. In 1954, the gardens were opened to the public. They named it the “Pa‘u-a-Laka Garden”, after the ancient Hawaiian name for the area (see Consultation Section 2.4). In 1968, the house was leased as a restaurant, and it was eventually taken over by the Kīahuna Plantation Resort (Hoverson 1985:22).

3.1.5 Modern Land Use

Following the merger of the plantation lands of the Koloa Sugar Company and Grove Farm Company in 1948, the combined lands under cultivation required new sources of irrigation water. In 1965, Grove Farm built a tunnel to bring the waters from Ku‘ia directly into the Waitā (Kōloa) Reservoir (Figure 9). Grove Farm leased these cane lands to McBryde Sugar Company when it terminated sugar operations in 1974 (Wilcox 1996).

By the late 1960’s, the main town of Kōloa experienced a type of reverse migration back to the shoreline. Although the town had established a Civic Center in 1977, the pace of tourist-driven development at the shoreline had been drawing construction and service jobs away from the town center. In 1962, the Wai‘ohai Resort opened, with the Sheraton Kaua‘i Resort following in 1965. The Kīahuna Plantation Resort opened in 1967, followed by the construction of various condominiums throughout the 70’s and 80’s. Finally, the Hyatt Regency Resort, with its’ expansive golf course, opened in 1991.

By this time, the tourist industry had successfully attached the name “Po‘ipū Beach” to the entire coastline beginning just west of the subject parcel at Kōloa Landing, and continuing east to Makahū‘ena Ledge. With the development of the Po‘ipū Bay Resort Golf Course and the Hyatt Regency Kaua‘i Resort Hotel, the Po‘ipū Beach name became synonymous with all two miles of coastline fronting the Wai‘ohai, Kiahuna, and Sheraton developments; ending at Po‘ipū Beach Park (Donohugh 2001).

By 1985, annual “Plantation Days” festivals were held in the open field adjacent to the former site of the 1841 sugar mill in Kōloa town. The Kōloa mill at Pā‘ā was finally closed in 1996, and remains a landmark of countryside as one makes the drive to Po‘ipū. Future plans within the Kōloa district will place more demands on beachfront properties along the Lāwa‘i and Po‘ipū coastline. Over 1,000 acres of former McBryde Sugar Company lands are slated for hotel and condominium development surrounding both coastal resort areas (Donohugh 2001). Future development plans for the upland areas involve both large tracts of lands, as well as regional redevelopment within Kōloa town itself.

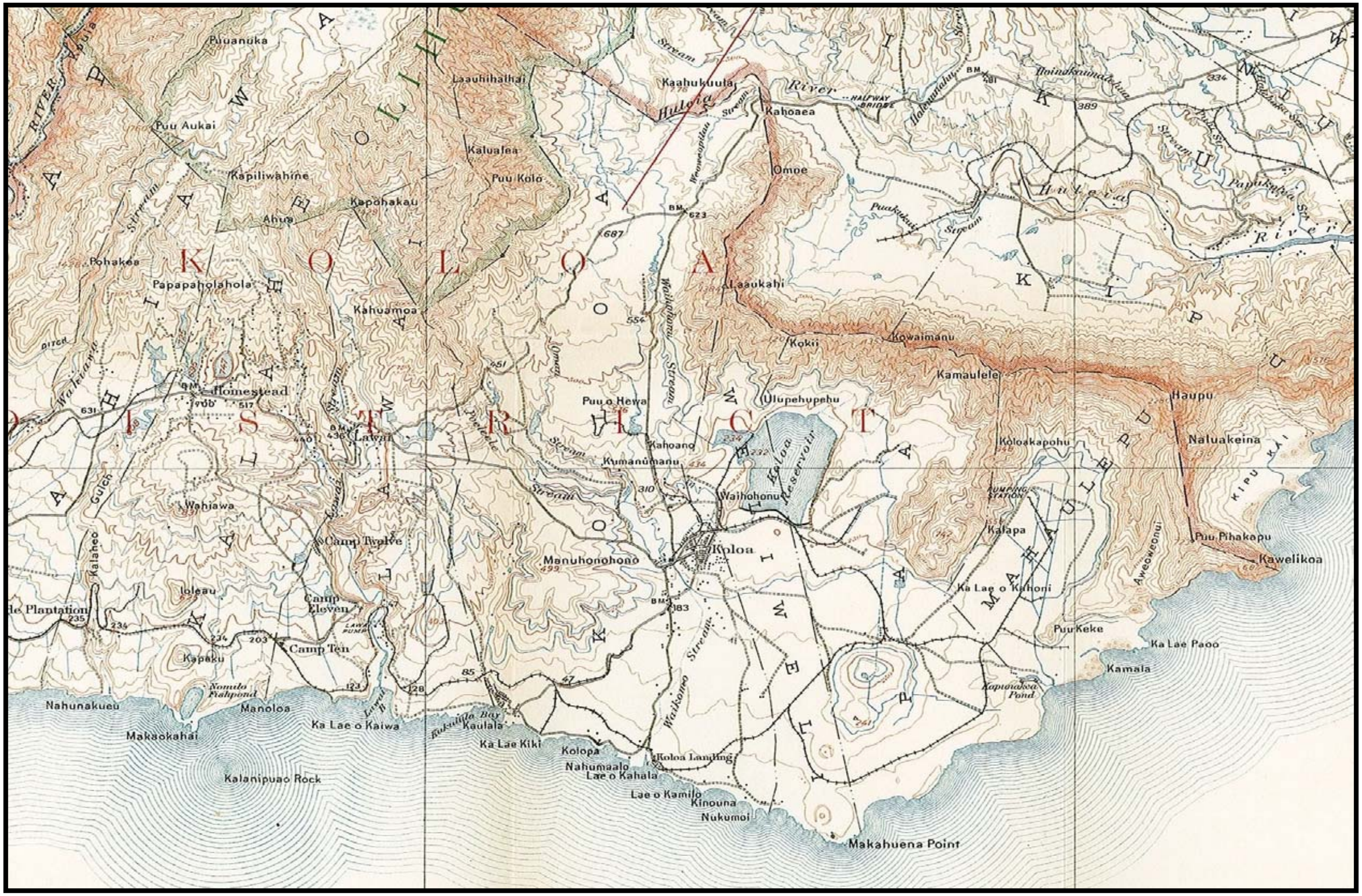


Figure 9. Map of the Kōloa Reservoir and irrigation ditches (adapted from U.S. Geological Survey, Kauai County, 1912 Edition).

3.2 Previous Archaeological Research

Previous archaeological research was conducted within the boundaries of the present project area by Jon Tulchin, A.S. and Hallett H. Hammatt, Ph.D., (CSH 2005), resulting in the identification of two possible platform remnants (CSH-1 and CSH-2) and the identification of a portion of the Kōloa Sugar Company's elevated metal irrigation flume. Additional research had been previously performed by Hallett Hammatt *et al* (CSH 1991), resulting in the identification of subsurface soils located along the southern project area boundary in association with work performed for the Poʻipulani Golf Course and Residential Development.

Most of the archaeological sites located to the south of the project area were originally located and described as part of the archaeological survey in support of the proposed Kīahuna Golf Village project (Hammatt *et al*. 1978). A total of 583 features were recorded in a total surveyed area of 460 acres. Sites were located and described with no subsurface testing taking place. Both habitation and agricultural sites were located, including stone enclosures, platforms, ʻ*auwai* (irrigation ditches), and terraced plots. Selective preservation or data recovery was recommended for sites in the Kīahuna Golf Village project area, as "they represent a highly significant cultural resource of substantial value for archaeological research and interpretation" (Hammatt *et al*. 1978).

An area southwest of the current project area was resurveyed as part of the archaeological survey for the proposed Kōloa/Poʻipū Bypass Road project (Hammatt *et al*. 1985). Archaeological work was completed but plans for the road realignment were abandoned and a completed report was never submitted to SHPD. A total of 47 previously identified, as well as undocumented, sites were located and described. These included structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt *et al*. (1978). Ten sites, including enclosures and C-shape structures, were selected for subsurface testing. "The testing showed only sparse evidence of occupation with no apparent cultural stratification" (Hammatt *et al*. 1985:i). The best examples of sites were recommended for either preservation or data recovery.

An area directly south of the current project area was resurveyed as part of the archaeological inventory survey in support of the proposed Poʻipūlani Golf Course and Residential Development project (Hammatt *et al*. 1991). This report was reviewed and accepted by SHPD along with a data recovery and preservation plan for the property (Hammatt 1991). A total of 75 sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt *et al*. (1978). Preservation was recommended for "major sites," and "all other sites which cannot be incorporated into the development should be subjected to a program of data recovery including subsurface testing and excavation" (Hammatt 1991: I).

A 260-acre parcel located north-northwest of the present project area was found to contain a remnant house site belonging to an original LCA. An inventory survey with subsurface testing was conducted (Jones *et al* 2004) within an area bounded by the Poʻeleʻele Stream and Kaumualiʻi Highway. LCA 3229 contained historic remnants of Eke ʻOpuni's homestead (SHIP 50-30-10-2072), which had consisted of sugar and taro lands. Terraces within the LCA were eroded and had been heavily impacted by modern sugar cultivation. A sugar plantation concrete irrigation ditch (SHIP -2073) was found filled with silt.

A 9.4-acre parcel located west of the present project area was found to contain seven historic-era sites (SHIP 50-30-10-3873-3879) consisting of twelve individual features. An inventory survey and subsurface testing was conducted on a parcel located along the Waikomo Stream in Kukui‘ula (Yorck, Chiogioji, and Hammatt 2004). Two irrigation flume remnants, four rock clearance mounds, three stone clearance alignments and three soil/rock berms were documented. Subsurface testing in the vicinity of State Sites -3873 and -3879 yielded no cultural materials. No pre-contact sites were observed in the heavily modified lands.

3.3 Overview of Archaeological Studies at Kōloa

Following an 1885 oral history project conducted by a student from Lahainaluna School, during which 14 temple platforms (*heiau*) and one fishing shrine (*ko‘a*) in the Kōloa area were described, Thomas Thrum was the next to document sites in the Kōloa area in his list of the *heiau* of Kaua‘i (Thrum 1907). He discussed six *heiau* in the district of Kōloa, which once extended from Hanapēpē to Māhā‘ulepū. The *heiau* were Hanakalauae, Kanehaule (inland Kōloa Ahupua‘a), Kihouna (Kōloa Ahupua‘a), Kaneiolouma (Kōloa Ahupua‘a), Weliweli (Weliweli Ahupua‘a), and Waiopili (Māhā‘ulepū Ahupua‘a). The two *heiau* on the Kōloa coast, Kaneiolouma and Kihouna, were described as: “near the Po‘ipū beach, at Kōloa, are two walled *heiaus* [sic] but a short distance apart.” (Thrum 1907:36-37;68)

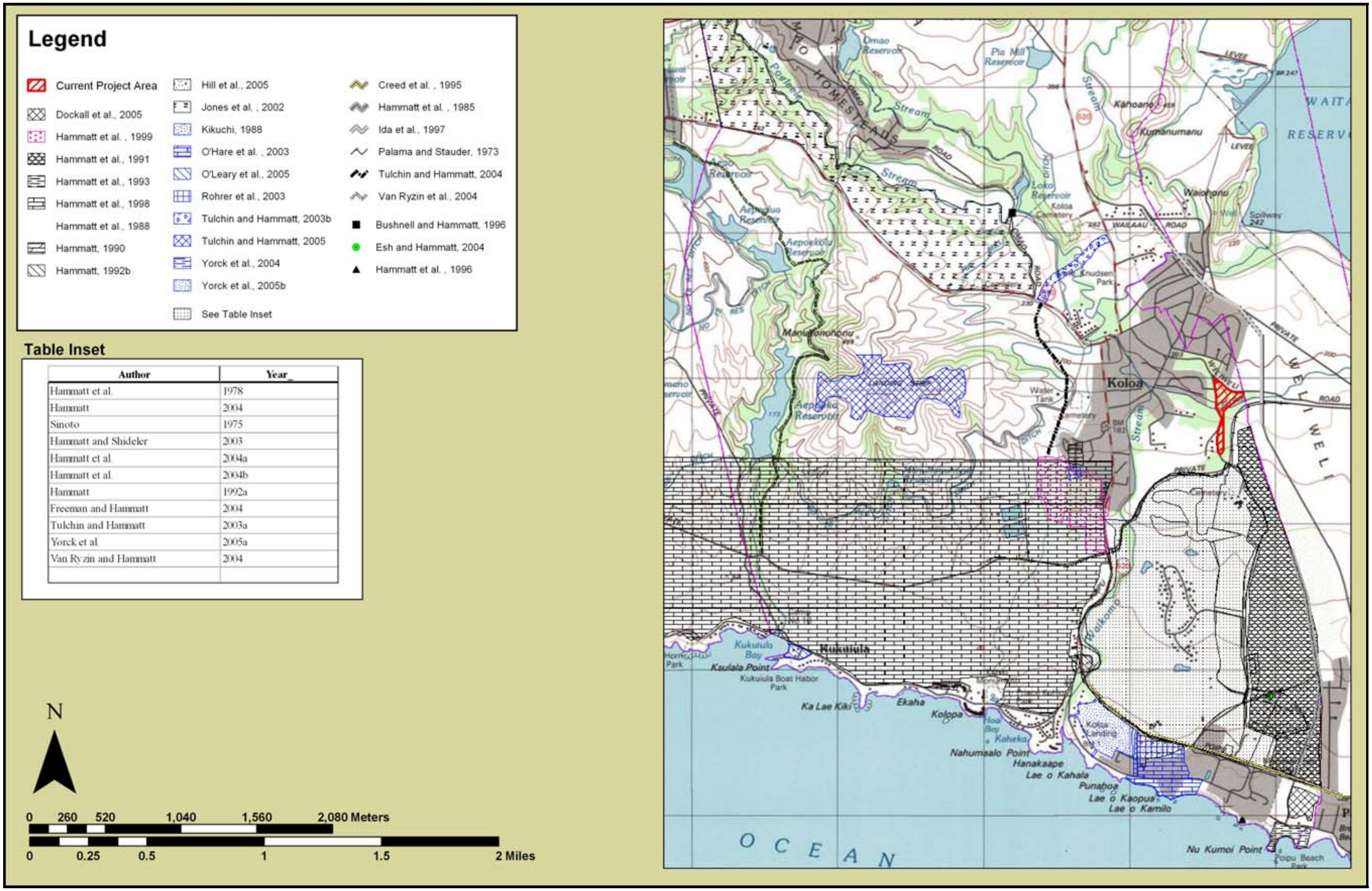
Table 1 contains a summary of all previously identified sites/features located within the vicinity of the project area. A synopsis of each investigation, including recommended treatment provided in earlier studies, follows the table. Figure 10 graphically illustrates areas of previous archaeological studies in the Kōloa Ahupua‘a.

Table 1. Previous Archaeology of the Kōloa Ahupua‘a and Vicinity.

NAME	YEAR	LOCATION	STUDY TYPE
Bennett	1931	Kukui‘ula Valley, Prince Kūhiō Park	Archaeological Survey
Kikuchi	1963	Kona District	Archaeological Survey
Kikuchi	1973	Hawaiian Fishponds	Archaeological Survey
Palama and Stauder	1973	Cane Haul Road-Kōloa Mill	Reconnaissance Survey
Sinoto	1975	Knudsen Trust Lands	Reconnaissance Survey
Bordner	1977	Kukui‘ula *‘auwai*, Site 50-39-10-1934	Reconnaissance Survey
Hammatt, Bordner and Tomonari-Tuggle	1978	Kīahuna Complex	Archaeological Survey
Connolly	1982	Kōloa-Po‘ipū Bypass Road	Reconnaissance Survey
Ching	1983	Kukui‘ula-Kualu, Alexander & Baldwin Lands	Reconnaissance Survey

NAME	YEAR	LOCATION	STUDY TYPE
Landrum	1984	Kukui‘ula-Kualu, Alexander & Baldwin Lands	Reconnaissance Survey
Hammatt, Borthwick and Shideler	1985	Kōloa-Po‘ipū Bypass Road	Survey and Subsurface Testing
Kikuchi	1988	Pa‘anau Sugar Camp	Reconnaissance Survey
Hammatt, Borthwick, Shideler, and Stride	1988	Kukui‘ula Bay Planned Community	Inventory Survey
Hammatt	1990b	Pa‘anau Housing Project	Inventory Survey
Hammatt, Folk, and Stride	1991	Po‘ipulani Golf Course	Inventory Survey
Hammatt	1992a	Kīahuna Parcel	Inventory Survey
	1992b	Poi‘pū and Lāwa‘i Road Junction	Reconnaissance Survey
Hammatt, Ida, and Folk	1993a	7.6-Acre Kōloa Parcel	Inventory Survey
Hammatt, Ida, Folk, Shideler, and Collin	1993b	Po‘ipū Beach Park	SubsurfaceTesting and Monitoring
Creed, Ida and Hammatt	1995	Po‘ipū Road	Inventory Survey
Bushnell and Hammatt	1996	‘Ōma‘ō Bridge, ‘Ōma‘ō Homestead	Archaeological Survey
Hammatt, Creed, and Ida	1996	Wai‘ohai Resort	Archaeological Survey
McMahon	1996	Sheraton Kaua‘i Resort	Reconnaissance Survey
Ida, Creed, and Hammatt	1997	Po‘ipū Bypass Road	Archaeological Survey
Hammatt *et al.*	1998	Kukui’ula Planned Community Phase I	Data Recovery
Hammatt *et al.*	1999	Kukui‘ula Planned Community Phase II	Data Recovery
Jones, Bush, Folk, Chiogioji, Shideler, and Hammatt	2002	260-Acre Parcel on Po‘ele‘ele Stream, ‘Ōma‘ō, Kōloa	Inventory Survey
Yorck, Shideler, and Hammatt	2002	Pīwai Well Sites, Pīwai Reservoir	Inventory Survey
Hammatt and Shideler	2003	34.735 Acre, Lot C-2, ‘Ōma‘ō Pīwai Reservoir	Inventory Survey
O’Hare, Shideler, and Hammatt	2003	Sheraton Kaua‘i Resort	Assessment Survey
Rohrer, T. Tulchin, and Hammatt	2003	Kapili Road, Po‘ipū 10.6 acre Parcel	Assessment Survey
Tulchin, T., and Hammatt	2003a	Knudsen Trust Parcel, Kōloa	Field Inspection

NAME	YEAR	LOCATION	STUDY TYPE
Tulchin, T., and Hammatt	2003b	Northern Portion of Western Bypass Road, Kōloa	Inventory Survey
Van Ryzin and Hammatt	2003	Knudsen Trust, Kōloa	Inventory Survey
Esh and Hammatt	2004	Poʻipū Village, Kīahuna Golf Course	Data Recovery
Hammatt, Ida, Masciangelo, and Folk	2004a	7.6-Acre Parcel 30, Poʻipū, Kōloa	Inventory Survey
Van Ryzin, Shideler, and Hammatt	2004	Aepo Waterline, ʻŌmaʻō Parcel	Data Recovery
Yorck, Chiogioji, and Hammatt	2004	9.4-Acre Parcel along Waikomo Stream, Kōloa	Inventory Survey
Yorck and Hammatt	2005	Kapili, Poʻipū and Hoʻonani Roads	Archaeological Monitoring
Yorck, Shideler, and Hammatt	2005b	25-Acre Parcel, Poʻipū	Inventory Survey
Dockall, Hammatt, Rainalter, Masciangelo	2005	Poʻipū Beach Park, *Mauka* Preserve	Inventory Survey
Hill, Dockall and Hammatt	2005	10.6-Acre Parcel Kapili Road Poʻipū	Inventory Survey
Yorck, Madeus, Freeman, Dockall, and Hammatt	2005a	Parcel 19 (Makai Portion) Knudsen Trust Parcel in Kōloa	Inventory Survey
Tulchin, J., and Hammatt	2005	8.5-Acre Parcel 1 (*Mauka* Portion) Knudsen, Kōloa	Literature Review and Field Inspection



Author	Year
Hammatt et al.	1978
Hammatt	2004
Sinoto	1975
Hammatt and Shideler	2003
Hammatt et al.	2004a
Hammatt et al.	2004b
Hammatt	1992a
Freeman and Hammatt	2004
Tulchin and Hammatt	2003a
Yorck et al.	2005a
Van Ryzin and Hammatt	2004

Figure 10. Map of Previous Archaeological Studies and Surveys within the Kōloa Ahupua‘a

The earliest systematic archaeological survey on the Island of Kauaʻi was conducted by Wendell Bennett in the late 1920s. Bennett examined and recorded 202 sites on the island. According to his site location map (Figure 6; Bennett 1931:98), Sites 74 to 81, 85-86, and 91-92 may be in the *ahupuaʻa* of Kōloa. He also described the Kihouna Heiau (Site 80).

Selected Bennett archaeological Sites located in Kōloa Ahupuaʻa:

Site 74. Fishing shelter. On the shore near the mouth of Kukuiula valley there is a fishing shelter.

Site 75. Kuhio Park, on the shore west of Waikomo stream, Koloa. Taro patches, a small heiau, an oven, paved house platform, fish pond, game ground with seats around, and a fishing shrine are the principal features shown.

Site 76. Salt pans, east of Waikomo stream along the shore.

Site 77. Ponds, just inland from the shore road at the east side of the Weliweli, Koloa.

Site 78. Taro terraces and house sites, just east of Site 77 and adjoining it.

Site 79. Walled inclosure [*sic*] and house sites, just northeast of Site 78, Koloa.

Site 80. Kihouna heiau, at Kihouna point, Poipu, Koloa.

Site 81. Kaneiolouma heiau, on the shore a short distance east of Site 80.

Site 85. Walls, inclosures[sic], house sites, in the cactus-covered country around the
Koloa reservoir and extending to the sea.

Site 86. House site, in the area described in Site 85.

Site 91. Holua slide, on the hill named Puu o Hewa just above Koloa off the main road.

Site 92. Kanehaule heiau, at Kaunuieie, Koloa.

These sites were further described by Bennett as:

Site 74. Fishing shelter.

On the shore near the mouth of the Kukuiula valley there is a fishing shelter (Pl. VI, *C*). It is 5 feet high, and 6 feet wide at the base. It is arched up of stone and used principally for a wind break.

Site 75. Kuhio Park, on the shore west of Waikomo stream, Koloa.

Taro patches, a small heiau, an oven, paved house platform, fish pond, game ground with seats around, and a fishing shrine are the principal features shown. Bennett's Sites 76 and 77 (later designated State of Hawaiʻi Sites 50-10-30-076 and -077) are shown on his site map (*ibid*:98) as very close to the project area. These sites were further described as:

Site 76. Salt pans, east of Waikomo stream along the shore.

In these numerous salt pans, some divisions are made by a single row of flat stones on edge, others by round stones in line, still others by a double row of stones with dirt or sand filled in between for a sort of a walk.

Site 77. Ponds, just inland from the shore road at the east side of Weliweli, Koloa.

> One of these ponds is of an oval shape 185 yards in circumference. It is encircled with a raised wall of dirt the edges faced with large stones. This raised portion is about 12 feet wide and built up 2 feet high most of the way around. Within this pond is a small circular wall of stones 2 feet wide, 2 feet high, and about 15 feet in diameter. A built-up path leads out to this circle. This pond is one of a series of four all similar in size and construction. There are not internal divisions, nor any great depth to these ponds (*ibid* 98).

William Kikuchi (1963) conducted a general survey of the Kona District of Kaua‘i including all *ahupua‘a* from Hanapēpē, eastward to Kīpū Kai. Information from Thrum (1907), Bennett (1931), a Lahainaluna School manuscript (1885), and other sources was instrumental in helping to locate major archaeological sites during the field survey. Kikuchi's survey was selective, as it was not designed to be a complete inventory, and focused on generally larger or more coastal sites. Kikuchi identified seven sites within east Kōloa (Figure 8; Sites 89-95), three of which were just west of Moir's Cactus Garden at the Kīahuna Plantation Resort, which is adjacent to the eastern boundary of the Sheraton Kaua‘i Resort.

> Site 89. Structures, Kane-milo-hai
>
> The area a little west of Moir's Cactus Garden and on the seaward side of the road was surveyed by the crew. On a pahoehoe ridge several walls were found most of doubtful antiquity. However, these walls could have been expanded from the original native walls in this area. Two brackish ponds on both sides of the ridge was [*sic*] found to have had walls within them. The probable use of these ponds as salt pans are very likely. A bulldozer had cleared much of the beach area and had uncovered much midden thus destroying sites here (Kikuchi 1963:66).

Kikuchi located this site between Kamilo and Ka‘ōpua Points and south of Po‘ipū Road on the coast. He identified the site as *Kane-milo hai*. According to legends, on the nights of Kāne the drums are heard to beat at the pool of Maulili, on Waikomo stream, and also at the sacred rocks, or *unu*'s, of Opuokahaku and Kānemilohae, near the beach of Po‘ipū. In 1963, Mr. And Mrs. Moir reported that they were sitting on the *lanai* of their house (a part of Moir's Cactus Garden) in the early evening and heard what sounded to be drums coming from the direction of the drum *heiau*. This *heiau* was said to have been a fertility *heiau* for women.

> Site 90. Shelters
>
> The land back of Moir's Cactus Garden was noted to have several round mounds of rock each with its opening facing seaward. If these were used as ovens the rocks would have been scorched, they were not. These would be ideal shelters but rather small in size.
>
> Site 91. Fish Shrine
>
> The brackish pond west of Moir's Cactus Garden was noted to have an overgrown platform just north of the road at the southwestern end of the pond. A low wall ran across the pond from this platform and formed a retaining wall on the eastern side. The small low platform, probably 5 by 9 feet, could be a shrine. However, closer inspection was not possible to confirm the theory (*ibid*:66).

Kikuchi (1963:66) located Sites 90 and 91 just west of Moir's Cactus Garden, which may have placed them within the northeast corner of the Sheraton Kauaʻi Resort. These sites were later given State (SIHP) Site Numbers 50-30-10-3086 and -3087, respectively. Kikuchi did not try to correlate these two sites to any described by Bennett, and according to SHPD lists, sites described by Bennett and Kikuchi are considered separate sites.

Kikuchi's Site 92 was Paʻū-a Laka, (SIHP 50-30-10-3088), a place where the *hula* was considered sacred. The *hula* grounds were reputed to have been located on the seaward side of Moir's Cactus Garden. Mrs. Sandie Moir originally named her gardens Paʻū-a-Laka due to the proximity to the *hula* grounds. Site 93 was a pond east of Paʻū-a-Laka, with walled divisions salt pans. Site 95 was Kihouna Heiau, a *heiau* on the coast that was reconstructed by Kikuchi (1985) after damage from Hurricane ʻIwa. Site 95 was Kane-i-olo-uma Heiau, a *heiau* on the eastern boundary of the *ahupuaʻa* of Kōloa.

Kikuchi also listed sites mentioned in other sources, but not relocated by him. In Kōloa, this included the *heiau* of Maʻulili. There are three areas in Kōloa named Maʻulili, the shore area, called Maʻulili-kai, the area inland of this, and an area in the town of Kōloa. Kikuchi believed that the *heiau* once was on the shore. He also reviewed the *heiau* listed by the Lahainaluna manuscript. This included Manini Heiau:

> Manini was another heiau of Koloa. It stood near the beach. The heiau was for the gods of the sea, that is Kuhaimoana and others. On the nights of Kane these fish-gods came up to the beach. Their spirits took possession of their keepers, then these men went into the heiau to drink awa. The people were accustomed to doing this in the olden days. One each night of Kane in every month, the drum was beaten to proclaim a kapu on the beach. Men were not allowed to go to the beach at night, lest they step on the fish (gods). (Lahainaluna School, cited from Kikuchi 1963:85)

William Kikuchi (1973) completed his dissertation on Hawaiian Aquacultural Systems in 1973. Within this study, he listed all known fishponds and classified them into six types. A "nameless pond" at Lae o Kamilo, Kōloa was classified as a Type II pond, 0.10+ acres, with a *koʻa* shrine (fisherman's shrine) within the pond. A Type II pond was called a *loku puʻuone* and is described as "an isolated shore fishpond usually formed by the development of barrier beaches building a single, elongated sand ridge parallel to the coast and containing one or more ditches and sluice gates" (*ibid*:228). In a survey of Kauaʻi fishponds completed in 1989 by Nancy McMahon, a pond on the Kōloa coast was classified as a Type II(b), which is a *loko puʻone* pond that was entirely excavated by man. McMahon describes this pond as "seen along Poipu shoreline, development has changed area, oval in shape, 185 yards in circumference, bank on *pahoehoe*" (MacMahon 1989). According to Bennett (1931) and Kikuchi (1963), there were several "salt pans" or brackish water pans along the Poʻipū coast. Bennett's Site 77, which is located more towards the east, adjacent to the *ahupuaʻa* of Weliweli, is described as a series of ponds, with one pond 185 yards in circumference (Bennett 1931). Thus, McMahon may be describing a different pond than Kikuchi.

Stephen Palama and Catherine Stauder (1973) conducted a reconnaissance survey along the route of the then-proposed main cane haul road to the Kōloa mill site. The proposed new section of road extended from Weliweli Road, southwestward across Poʻipū Road, connecting to an existing cane haul road. This road corridor crossed a portion of Weliweli Ahupuaʻa and both east and west Kōloa at a distance of between two-thirds to two miles from the coast, well north of the current project area. A total of 18 sites were recorded along the road corridor. Although the Palama and Stauder study was limited in scope to the proposed road right-of-way, it included a short but thorough historical summary of the locations of archaeological sites within the context of the Kōloa Ahupuaʻa and Weliweli Ahupuaʻa. An extensive *ʻauwai* system was observed east of Poʻipū Road. The following comments on this system and the sites in general are relevant to understanding the archaeological significance of the area as a whole, and the historic processes at work:

> Our reconnaissance revealed that the most significant archaeological feature located within the study area is the extensive *ʻauwai* system. Remnants of this irrigation system were observed on both sides of the Waikomo Stream...[This] network of watering canals proved to be the key to the success of the prehistoric Hawaiian Culture in turning these marginal lands into flourishing wet and dry agricultural fields. From information gathered from local informants and preliminary historical investigation of this area it is evident that the early commercial growers of sugar cane utilized the existing *ʻauwai* system. Gradually as more and more fields came under sugar cane production these replaced the wet and dry fields of an earlier day. Today the archaeological sites remaining stand as islands as these marginal cane lands were taken out of production and turned into pasture (*ibid*:4).

Akihiko Sinoto (1975) conducted a reconnaissance survey of 400+ acres of Knudsen Trust Lands at Kōloa, in the area north of Poʻipū Road, to the southwest of the present project area. He recorded several features and suggested they were the northern remnants of Bennett's Sites 78, 79, 85 and 86. Sinoto located many sites with both habitation and agricultural features along the southern portion of the study area: from the site of the present sewage treatment plant to the boundary of the study area at Weliweli.

Richard Bordner (1977) conducted a one-day reconnaissance survey of a specific *ʻauwai* located in Kukuiʻula, which corresponded to the major *ʻauwai* system assigned SIHP Site 50-30-10-1934. The *ʻauwai* traversed Kukuiʻula from northeast to southwest and included a number of associated remnant fields. A portion of this *ʻauwai*, (which consisted of a raised "aqueduct" type section), was recommended for preservation, and remains as a unique feature of the Kōloa Field System (ibid. 1977:26).

Hallett H. Hammatt, Richard Bordner, and Myra Tomonari-Tuggle (Hammatt *et al.* 1978) as part of Archaeological Research Center of Hawaii (ARCH), reported on a general survey of 460 acres for the then-proposed Kīahuna Golf Village, located on the east side of Waikomo Stream and Poʻipū Road. The project area consisted of a major complex of well-preserved, nearly contiguous and highly integrated agricultural and habitation features. The Kīahuna survey recorded 583 archaeological sites including 175 stone enclosures and 108 stone house platforms, some of which appeared as clusters of family compounds. The water channels (*ʻauwai*), ponded fields, terraced plots, and mounded fields all indicated extensive wet and dry land agriculture (*ibid*:5). The water source for this highly integrated agricultural system, called the Kīahuna Complex, was Waikomo Stream, which was tapped upstream. Additional sites included 10 occupation caves and a *heiau*.

Hallett H. Hammatt (Hammatt 1979) conducted an inventory survey of a dune system located at Keoneloa Bay. (Archaeological and Historic Investigations, Keoneloa Bay, Weliweli, Pā‘ā, Kona Kaua‘i ARCH 14-76, Lawa‘i, Kaua‘i, Hawai‘i.) Pre-historic burials were disinterred and relocated to an archaeological preserve, and other pre-contact sites were recorded.

William Kikuchi (1979) conducted a reconnaissance survey of the *mauka* portion of the Sheraton Kaua‘i Resort, north of Po‘ipū Beach Road, in 1979. This survey took place before the Sheraton Kaua‘i Resort expanded construction of their hotel to their northernmost parcel, although some sections had been significantly altered by bulldozers and paved for use as a parking lot. Kikuchi found agricultural features in the northeastern portion of the project area, and concluded that the area lay within the coastal fringe part of the agricultural and habitation zone that extended inland all the way to Kōloa town. A tidal pool, a railroad berm, and several stone walls were also recorded in the area.

Robert Connolly (1982) conducted a reconnaissance survey of sections (310 acres) in the *ahupua‘a* of Kōloa and Weliweli in 1982 for the Kōloa-Po‘ipū Bypass Road. The sites that Connolly encountered were predominantly wall remnants, a few rock mounds, a hole, two complexes, a railway causeway, and an enclosure.

Francis Ching (1983) conducted a reconnaissance survey, and an historical investigation of 230+ acres of Alexander and Baldwin lands within the *ahupua‘a* of Kōloa (west Kōloa) and Lāwa‘i. According to Ching, three-fourths of the study area was bulldozed, with many rocks re-located, however, remnants of walls, *lo‘i* (wetland cultivation), ‘*auwai* (irrigation ditch) flumes, terraces, and an historic railroad berm were still discernable. These remnants are evidence of the great expanse of the Kōloa Field System.

James Landrum (1984), of the Bishop Museum, conducted a reconnaissance survey of a 200+ acre portion of Kukui‘ula. Landrum recognized that his survey area was once part of an extensive irrigated agricultural complex developed in the prehistoric period with superimposed historic-era occupation.

Hallett H. Hammatt, Douglas Borthwick, and David W. Shideler (1985) conducted a survey with subsurface testing for the proposed Kōloa-Po‘ipū Bypass Road, which extended 9,000 ft. along the boundary of Kōloa and Weliweli Ahupua‘a. The road corridor was proposed to connect Po‘ipū Road (the beach road) to Weliweli Road, southeast of Kōloa Town. A total of 47 archaeological features were located along the corridor. These were concentrated at the southern end of the corridor and included the southeastern portion of the "Kīahuna Complex" documented by Hammatt *et al.* in 1978.

Hallett H. Hammatt, Douglas Borthwick, David W. Shideler, and Mark Stride (Hammatt et al. 1988) conducted an archaeological inventory survey in the 1000-acre proposed Kukui‘ula Bay Planned Community. Fifty-eight archaeological sites were recorded; many associated with the Kōloa Field System. Two to three *heiau* were found, possibly including the remains of Kamaloula Heiau.

William Kikuchi (1988) conducted a reconnaissance level survey of the former Pa‘anau Sugar Camp. The camp was located just south of the present day Kōloa Elementary School. The survey recorded a number of cement foundations, ditches, and portable historic artifacts. Kikuchi states that archaeologically, the site is interesting because it contains remnants of an early (1910-1950) plantation camp, even though the vast majority of its structures have been destroyed or removed.

Hallett H. Hammatt (1990b) conducted an inventory survey of a 4.7-acre parcel at the west end of Paʻanau Road near Kōloa town. The historical segment of this report indicates the previous existence of the Paʻanau Camp, and a railway and ʻ*auwai* irrigation ditch which traversed the study area. However, the survey revealed the absence of any traces of pertinent features.

Hallett H. Hammatt (1991) carried out an archaeological reconnaissance for a proposed waterline stream crossing of Pōʻeleʻele Stream, north of Kōloa town. He noted extensive modern land modification and no significant findings.

Hallett H. Hammatt, William H. Folk, and Mark Stride (1991) conducted an archaeological inventory survey of 160 acres within Kōloa along the *ahupuaʻa* boundary of Kōloa and Weliweli. They located, mapped, described, and interpreted a total of 75 sites and observed a wide range of site types. Of the 75 sites identified, 12 were classified as no longer significant. 61 of the 63 remaining sites were classified as significant under Criterion D, and, of these, 10 sites were also classified as "Excellent examples of site types" under Criterion C. A total of eight sites were classified as "probable burials" and were grouped under Criterion E. This survey indicated that the Poʻipūlani project area contained traditional *ʻauwai* and associated *kula* and *loʻi* features consistent the Kōloa Field System. A data recovery and preservation plan for the Poʻipulani Development Area recommended the, "Total preservation of 12 archaeological sites (86, 900, 913, 926, 934, 938, 939, 946, 947, 953, 966 and 967)". A schedule of excavations and tests affecting 51 sites consisting of habitations, ʻ*auwai*, caves, and field walls was recommended,

Hallett H. Hammatt (1992a) carried out an archaeological inventory survey of a 3.8 acre property at Kīahuna, (TMK 2-8:014-026), but the entire parcel had been previously graded and there were no significant findings.

Hallett H. Hammatt (1992b) carried out an archaeological reconnaissance of the Poʻipū Road and Lāwaʻi Road Junction near the mouth of Waikomo Stream, but again there were no significant findings, owing to prior land disturbance.

Hallett H. Hammatt, Gerald K. Ida, and William H. Folk (Hammatt *et al*. 1993a) conducted an archaeological inventory survey, with limited subsurface testing, of 7.6 ac. (TMK 2-8-14:30) in east Kōloa. This parcel is north of Poʻipū Road and south of the former railroad grade. Site 3758, a house platform or possible *heiau*, was re-mapped, and three new sites habitation/agricultural complexes were recorded. According to Hammatt *et al.* (1993:21), these sites are remnants of traditional ʻ*auwai*, walls, fields, enclosures and habitation platforms, and appear to be a part of the larger Kōloa Field System, which encompassed over 1000 acres.

Hallett H. Hammatt, Gerald K. Ida, William H. Folk, David W. Shideler and Brian Collin (Hammatt *et al*. 1993b) conducted an assessment survey, subsurface testing and monitoring at Poʻipū Beach Park in the *ahupuaʻa* of Kōloa. Wave action during Hurricane ʻIniki in 1992 had exposed a cultural layer (Site 50-30-10-745) which needed to be preserved and monitored during the reconstruction and restoration of the park. Auger testing (*ibid*:11) revealed charcoal, and both traditional and historic midden and artifacts (*i.e.* basalt flakes and fragments, nails, glass, *kukui* shells, and mollusk shells). An historic cemetery (State Site 50-30-10-1871), located in the middle of Poʻipū Beach Park, and other sections of the buried cultural layer beneath the park, were also monitored during the removal of several cement slabs, remnants of a pavilion, picnic tables, and barbecues. Three radiocarbon dates were determined for this layer: the earliest was

A.D. 1282-1414 and latest ranged from A.D. 1678-1940 (*ibid*:52). The rich cultural layer, supported by radiocarbon dating, indicates that this shoreline occupation is contemporaneous with the development of the Kōloa Field System. This cultural layer is the "single largest coastal beach deposit in the *ahupuaʻa*...of Kōloa" (Hammatt *et al.* 1993b:65, 66) and greatly contributes to the information bank regarding the cultural development of the Kōloa district.

Victoria S. Creed, Gerald K. Ida and Hallett H. Hammatt (1995) reported on an inventory survey within a 1.4-mile corridor along the *mauka* (inland) side of Poʻipū Road (TMK 2-8-15, 16, 17 & 18) in the *ahupuaʻa* of Kōloa and Weliweli. Three sites, including enclosures, a terrace, and the Kōloa-Weliweli boundary wall, survived previous bulldozing of the area and were understood as components of the Kōloa Field System.

Kristina W. Bushnell and Hallett H. Hammatt (1996) carried out an archaeological investigation of ʻŌmaʻō Bridge in ʻŌmaʻō Homestead but the only objects of historical interest noted were the existing bridge and features associated with an old railroad.

Hallett H. Hammatt, Victoria S. Creed, and Gerald K. Ida (1996) conducted an assessment survey of an exposed cultural layer in undisturbed sand deposits at the Marriott Waiʻohai Resort. This layer was disturbed by high wave action during Hurricane ʻIniki, which completely destroyed the associated reconstructed Kihouna Heiau (Site 50-30-10-80). Three charcoal samples from this layer were dated to A.D. 1430-1950. The exposed cultural layer supports the potential existence of widespread intact cultural areas along the general shoreline (Hammatt *et al.* 1996:36, 39).

Nancy McMahon, (April 1996) at the time an independent archaeological consultant, completed a reconnaissance survey of TMK 2-08-16:3 (8.444 acres), a part of the Sheraton Kauaʻi Resort, to report on damage caused by Hurricane ʻIniki. The reconnaissance was performed immediately *makai* of the current project area, south of Poʻipū Beach Road. No surface sites or cultural deposits were reported. She noted a sandy deposit up to the foundations of the buildings on the eastern side the Resort near Lae o Kamilo. She suggested that the remnants of beach dunes could still exist and recommended monitoring of any construction in this area in case historic sites, including human burials, were uncovered.

Beginning in December of 1996, reconstruction of areas damaged by the hurricane began at the Sheraton Kauaʻi Resort. Excavations took place to construct new buildings on new concrete pads, Pads A to C (from west to east), in the southeastern corner of the hotel area (*makai* of Poʻipū Beach Road.) Construction began on Pad B in December, beginning with the removal of a large banyan tree. At that time, an intact cultural layer, designated Layer III was uncovered. Subsequent field work included monitoring of all grading and excavation work at Pads B and C, excavation of all drain lines around Pads A, B, and C, and excavation of a large swimming pool south of Pad A. Twenty-two test units and three shovel tests were also excavated by the workers in portions of the project area with intact cultural deposits. This work continued into the beginning of 1998.

The cultural layer, Layer III, was a dark sandy layer. This layer was found to be intermittent and disturbed in the drain lines north, south and west of Pad B. It was the thickest and least disturbed on the east side of Pad B and extending into Pad C. A five-unit grid was placed in the sandy area exposed below the banyan tree. One feature, a fire pit (Feature G) was exposed. After grading of the Pad B area was complete, human skeletal remains (Burial #2) were found in the excavated material. No *in situ* location for this burial was observed. During monitoring of the rest of the project, a total of ten subsurface features (Features B-K) were discovered. Six were fire pits, one was a stain, one was a concentration of fire-cracked rocks, one was a C-shaped structure, and one was a pig skeleton. Eight burials (#1-8) were also uncovered within Layer III (Note: Feature A was later renamed Burial #1).

The features and burials were distributed around Pads A to C. One burial (Burial #2) and two fire pits (Features E and G) were uncovered under Pad B. Two burials (Burials # 7 and #8) were uncovered during excavation of the plumbing trenches around the pool south of Pad A. Burial #7 was a burial that had been disturbed during the construction of the original hotel in the 1960s. At that time, Burial #7 was reburied in a redwood box. The remaining eight of the ten total features (Features B-D, F, H-K) and the remaining five of the eight total burials (Burials #1, 3-6) were all found within Pad C or just north of it. The most interesting feature uncovered was Feature H, found in the Pad C area, and excavated within Test Units 15-22. This feature was a C-shaped shelter, 3.0 m long, 2.4 m wide, with walls 0.65 m high, built of upright basalt and sandstone slabs. The shelter contained a variety of cultural material, including marine shell, bone, charcoal, fish hook fragments, coral abraders, bone awls, basalt flakes, urchin spine files, and a octopus lure weight. Six charcoal samples were submitted for radiocarbon age determination for Layer III. These ranged from 20+/- 70 BP (before present) to 540+/- 60 BP, indicating that the earliest possible date for the features was A.D. 1400. It may have been constructed much later. All human skeletal remains were reburied at a location north of Poʻipū Beach Road, marked by a plaque and a reconstruction of Feature H.

Gerald K. Ida, Victoria S. Creed and Hallett H. Hammatt (1997) conducted a reconnaissance survey on a 1.2 mile corridor of a proposed bypass road within the *ahupuaʻa* of Kōloa and Weliweli (TMK 2-8-02:3, 2-8-03:1, 2-8-04:1, 2-8-05:2) that had previously been bulldozed. This road extended from an existing bypass road at the coast to north of Kōloa town. This survey did not reveal any archaeological sites, and further study was not recommended.

Hallett H. Hammatt, Rodney Chiogioji, David W. Shideler, Douglas Borthwick, Matt McDermott, and Ian Masterson (Hammatt *et al*, 1998) reported on data recovery of the Kukuiʻula Planned Community Project Phase 1 area encompassing approximately 219 acres (Hammatt *et al*. 1998). The project included excavations at 20 different sites, which encompassed 64 individual features. There were a total of 212 excavation units (212 square meters) and 19 backhoe trenches (only 14 backhoe trenches were chosen for study). Large quantities of midden (approx. 23.7 kilograms) and artifacts (10,635 items) were recovered and were reported on. The artifacts include a wide range of types with both indigenous (2,592 items) and historic (8,043 items) represented. Radiocarbon (C14) dates ranged from ca. A.D. 1050 onward. The earliest date came from the habitation/burial cave Site 50-30-10-1927A. In addition to the habitation sites and features dated, seven dating samples from agricultural features were also analyzed.

Hallett H. Hammatt, Kristina W. Bushnell, Gerald K. Ida, Rodney Chiogioji, Victoria S. Creed, David W. Shideler (Hammatt *et al*, 1999) performed data recovery of an parcel southwest of Kōloa Town, on the west bank of the Waikomo Stream, in the northeastern portion of the Kukuiʻula Planned Community Phase II Area. The study area consisted of approximately 33 acres that had been used as a buffer zone between cane lands/pastures and residential lots bordering Poʻipū Road. While some ten Land Commission Awards (LCA) lay partially or entirely within the project area, most of these properties were bulldozed in the course of sugar cane cultivation. There were areas that appeared undisturbed by sugar cane cultivation. Excavations were conducted within five archaeological sites consisting of 13 features. These excavations yielded 264.8 grams of midden; 53 indigenous artifacts (including 43 volcanic glass flakes, 9 basalt flakes, and one coral manuport); and 877 late-historic artifacts (*e.g.* glass, metal, ceramics, plastic, leather, and slate). Twelve charcoal samples were dated, and ranged from A.D. 1250-1410 to A.D. 1800

C. Kulani Jones, Tony Bush, William H. Folk, Rodney Chiogioji, David W. Shideler and Hallett H. Hammatt (2002) conducted an inventory survey with subsurface testing within a 260-acre parcel located along the Poʻeleʻele Stream, at ʻŌmaʻō. At LCA 3229 (SHIP 50-30-10-2072), remnants of a historic habitation and associated "eroded taro and sugar cane cultivation terraces" were recorded. The LCA had been awarded to "Eke ʻOpuni", and had been heavily impacted by modern sugar cultivation. A plantation-era irrigation ditch (SHIP 50-30-10-2073) was characterized as "modern", and was recorded as "filled with silt".

Jesse Yorck, David W. Shideler, and Hallett H. Hammatt (2002) conducted an inventory survey of three proposed well sites near Pīwai Reservoir north of ʻŌmaʻō Homesteads. The project area was located north of the present project area. No archaeological sites were identified in the project area or vicinity.

Constance R. O'Hare, David W. Shideler, and Hallett H. Hammatt (2003) conducted an archaeological assessment of two parcels associated with the Eric A. Knudsen Trust Lands in the Kōloa Ahupua'a. Five archaeological features, which may have constituted one or more archaeological sites, were located and identified. These features were all located within the boundaries of the Sheraton Kauaʻi Resort. Two rock platforms with associated walls and/or alignments, a series of three agricultural terraces, a linear rock mound and a tall, circular enclosure, were assigned five separate temporary feature numbers during the 2003 assessment. In addition to these features, limited testing was conducted on two rectangular platforms located within the intensely developed garden and pool area of the hotel grounds. The platforms were excavated to a depth of 120 centimeters below the surface. No cultural material or human skeletal remains were found.

Steven Rohrer, Todd Tulchin, and Hallett H. Hammatt (2003) conducted an archaeological assessment of approximately 10.6 acres of Eric A. Knudsen Trust Lands in the Kōloa *Ahupua'a*. Two archaeological sites, consisting of a temporary habitation enclosure and a temporary habitation overhang shelter, were identified, assigned State of Hawaiʻi site numbers, and documented. These sites were located in the northern nine acres of the project area. The project area was bisected by an elevated railroad berm, which was constructed of faced basalt boulders. The railroad berm separated a one-acre section of the project area from the preceeding nine acres. The one-acre subsection of the project area consisted of a cleared lot with a small single-wall-construction residence, and was segregated from Kapili Road by a low, modern rock wall.

Todd Tulchin and Hallett H. Hammatt (2003a) conducted an archaeological survey within a 840-meter-long by 60m wide road corridor as part of a search for a proposed bypass corridor in Kōloa. No archaeological sites were identified in the project area or vicinity, and the report noted extensive land modification associated with sugar cane, banana, and macadamia nut cultivation.

Todd Tulchin and Hallett H. Hammatt (2003b) conducted an archaeological assessment survey of certain Eric A. Knudsen Trust lands located *mauka* (toward the mountains) of Po‘ipū Road. A large number of cultural sites, although previously recorded, were found to be intact.

Karl Van Ryzin, David W. Shideler, and Hallett H. Hammatt (2004) conducted an archaeological inventory survey along the 4.8-kilometer (3-mile long) length of a 4.36-acre waterline right-of-way for the Aepo waterline. They noted substantial historic land modifications, but no significant findings.

Karl Van Ryzin and Hallett H. Hammatt (2004) conducted a data recovery project within the Village at Po‘ipū, Phase I, (TMK: 2-8-14: 19 portion), during which four sites (SHIP 50-30-10-908, -909, -969, and –973) were excavated. The sites appeared to be remnants of an *‘auwai* system. A small amount of midden and charcoal was collected at sites -908 and –909. No cultural material was present at sites –969 and –973.

Hallett H. Hammatt, Gerald K. Ida, Sarah Masciangelo and William Folk (2004a) conducted an archaeological survey with subsurface testing for Parcel 30 of the Eric A. Knudsen Trust Lands. The 7.6-acre parcel had previously been surveyed by Hammatt (1978 and 1992a) and Hammatt, Ida and Folk (1993a). During the 2004 study, subsurface testing determined that five sites (SHIP 50-30-10-947, -992, -3756, -3757 and –3758) be recommended for preservation. Three sites (SHIP –539, -540, and –541) were classified as not significant.

Hallett H. Hammatt, David W. Shideler Constance R. O’Hare, and William H. Folk, (2004b) conducted an inventory survey of five project areas on approximately 400 acres of the Kīahuna Golf Village; wherein 509 historic properties were documented and 80 historic properties were excavated. The 509 historic properties included 238 permanent habitation sites, 150 temporary habitation sites, 2 habitation/agricultural sites, 104 agricultural sites, 2 artifact sites, 1 rock art site, 1 historic grave, 1 ceremonial site, and 10 miscellaneous sites used for either storage or livestock.

The Kīahuna Golf Village inventory survey included data recovery within 80 historic properties. 12,153.7 grams of midden were excavated, which included 1017 indigenous artifacts (607 lithic items, 174 bone items, 148 coral items, 45 shell items, 41 sea urchin items and 2 “other”) and 109 historic artifacts (glass, metal, ceramic and slate items). The “Kōloa Field System” observed within the project area was described as, “unique”. The description went on to read, “The field systems of Kōloa are unique, in that they are laid out on almost bare lava rock. Attesting to the degree of planning and labor that went into them, as far as is known, there are no other examples of this type in Hawai‘i. The Kōloa Field System, as surveyed in this report, has remained intact despite encroachment by cattle grazing and development of sugar cane lands”(Kiahuna Archaeological Inventory Survey and Testing of 460 Acres, Volume 1, Archaeological Analysis, January 2004).

The earliest Kīahuna Golf Village sites were carbon-14 dated to the thirteenth through the fifteenth centuries A.D. (SHIP 50-30-10-3841), with sites dated into the sixteenth century (SHIP 50-30-10-3822). According to this inventory survey, The Kōloa Field System continued to expand throughout the eighteenth century A.D., and ceased to function as a field system when sugar cane cultivation took over the existing *‘auwai* system for it’s own use.

Jesse Yorck, Rodney Chiogioji, and Hallett H. Hammatt (2004) conducted an inventory survey of a 9.4-acre parcel located at the intersection of Waikomo Stream and Po‘ipū Road in

Kōloa Village. The project area contained historic remnants of sugar operations by the McBryde Sugar Company. Twelve features (two irrigation flumes, four rock clearance mounds, three stone clearance alignments and three soil and rock berms) were assigned seven SIHP numbers. Two sites (SIHP 50-30-10-3873 and -3879) were tested, but no significant cultural materials were found.

Kelley S. Esh and Hallett H. Hammatt (2004) conducted an archaeological survey of the historic railroad berm located within Parcel 19 of the Eric A. Knudsen Trust Lands, and made recommendations for the demolition and reconstruction of a part of the berm affected by the development of the Kīahuna Golf Village project.

Jon Tulchin and Hallett H. Hammatt (2005) conducted an archaeological field inspection of the present project area (8.633-acres) with an associated literature review. A historic irrigation flume was identified and assigned a State Inventory of Historic Places Site Number (50-30-10-3926). Although modified by sugar cane cultivation, two potential sites (CSH-1 and CSH-2) were recommended for testing.

Jesse Yorck, David W. Shideler, and Hallett H. Hammatt (2005b) conducted an inventory survey of an approximately 25-acre parcel located northwest of the Sheraton Kauaʻi Resort at the intersection of Poʻipū and Kapili Roads. Twenty-one archaeological sites consisting of approximately 70 associated features were documented in an area that contained two LCA's. LCA 3606 (to Kamae) and LCA 10272 (to Makalulu) were both located along the eastern bank of Waikomo Stream, at the western edge of the project area. Approximately 12 enclosures, 14 walls or wall segments, 7 mounds, 8 terraces, 11 C-shapes, 8 modified outcrops, a railroad berm and 12 specialized features were located and documented. The report recommended preservation and limited data recovery of Site 50-30-10-0374 (habitation caves and associated rock-filled areas), and data recovery of Sites -0368, -0369, -0370, -0373,- 0376, and -0947 (the railroad berm). The parcel was characterized as containing mostly pre-contact habitation sites. Some walls were identified as historic ranching-era structures.

Jesse Yorck and Hallett H. Hammatt (2005) conducted archaeological monitoring of electrical utility trench work dug around the western perimeter of a project area previously assessed by CSH (Rohrer 2003) and subsequently surveyed (Hill 2005). The trenches were dug to provide electrical utility improvements for properties in the immediate vicinity of the present project area. No cultural material was observed during the monitoring process.

Robert R. Hill, Jon Tulchin and John E. Dockall (2005) conducted an inventory survey of the 10.6-acre parcel previously assessed by Rohrer *et al* (2003). Two previously noted habitation sites were documented, and a third site, related to the construction of the railroad berm, was recorded. The elevated railroad berm was documented and recommended for preservation.

John E. Dockall, Uta Rainalter, Sarah Masciengelo, and Hallett H. Hammatt (2005) conducted an inventory survey of 6.388 acres located at the Poʻipū Beach Park, *Mauka* Preserve. Eight sites consisting of 68 component features were identified and documented. The report recommended preservation of all eight sites. Previous site preservation work had been conducted by members of the *Ka hui malama o Kane I olo uma* group. All features associated with Sites 50-30-10-3886 through 3893 were thoroughly documented with no further work recommended. If the current preservation project by *Ka hui malama o Kane I olo uma* could not continue, additional testing was recommended for Sites 50-30-10-3886K, -3886J, -3888E, -3891A, -

3892C, -3893D, and -3893H. In addition, the sites were interpreted as belonging to an agricultural complex that included a fishpond (SIHP Site 50-30-10-3887). The report recommended that each site be interpreted with reference to the entire complex.

Jesse Yorck, Jonas Madeus, Sallee D. M. Freeman, John E. Dockall and Hallett H. Hammatt conducted an inventory survey of the *makai* portion of parcel 19 of the Eric A. Knudsen Trust Lands (Yorck, *et al* 2005). This parcel is located southeast of the current project area. The 18-acre parcel contained 16 sites, of which 15 had previously been documented (SHIP 50-30-10-3766, -3769, -3770, -3771, -3775, -3779, -3785, -3790, -3791, -966, -3896, -3897, -3898, -3899, and –3900), and one was newly identified (-3905). Ten sites were listed as habitation-related, three were agriculture-related, one was classified as “storage”, and one was a remnant of an *ahupua‘a* boundary. Site 966 was classified as a complex, consisting of both agricultural and habitation features. Material evidence of historic occupation was not found during this survey, although there was evidence of modification from sugar cultivation and ranching.

3.4 Previous Archaeology Summary

Previous archaeological work concerning the Kōloa district has, until recently, been mostly surface surveys. The Kōloa area began to be documented by subsurface testing of sub-surface cultural deposits within the proposed Kīahuna Golf Course area in 1979. Information gleaned from intensive excavations in the *ahupua‘a* of Kōloa, Weliweli, and Pā‘ā, combined with the inventory surveys in these *ahupua‘a*, clearly indicate an expansive pre-contact irrigated agricultural complex and associated temporary and permanent habitation features. The focus of this integrated Kōloa Field System was Waikomo Stream, which was utilized as the main source of irrigation. However, the full extent of the Kōloa Field System is hard to estimate because of the widespread historic land modifications (mainly for sugar cane).

The most significant series of projects conducted within the vicinity of the current project area involve work done on behalf of the proposed Po‘ipulani Golf Course and Residences. In 1991, Hallett H. Hammatt, William H. Folk and Mark Stride recorded seventy-five sites, of which twelve were considered no longer significant. Sixty-three sites were considered significant, with preservation of twelve sites and archaeological data recovery of fifty sites mandated by the State Historic Preservation Division. The report also noted several possible burials (SIHP Sites 50-30-10-919, -9260, -927, -936, -and -940) that were to be tested in order to determine if they were burials. Two cave sites, a small tube shelter (SHIP -939) and a long tube shelter (SHIP -946) were suspected burial sites, and were scheduled for preservation. Several other projects were performed at the *makai* (seaward) property boundary of the 1991 Po‘ipulani parcel. Inventory surveys by Yorck, et al (2005), Van Ryzin and Hammatt (2004), and Esh and Hammatt (2004), have shown

3.5 Background Summary and Predictive Model

From previous archaeological studies and historic accounts it appears that habitation and intensive irrigated agriculture were widespread in central and coastal Kōloa. As an extensive irrigated complex, the Kōloa Field System was used to divert the waters of the Waikomo Stream for taro, native sugar, and fish. As the Judd (1935) account asserts, it is likely that low inland areas were used for less intensive cultivation of patches of sweet potato, *pia*, (arrowroot) and *wauke* (paper mulberry) and the gathering of *hala*, (pandanas fiber) *kukui* nuts (the oils having medicinal applications) and other resources. The coastal portion of the *ahupua‘a* would be a focus for permanent habitation, collection of marine resources, ceremonial activities, and burials. The archaeology of the region also seems to bear out the accuracy of Judd's account.

Chronological analysis from Kōloa, and the two neighboring *ahupua‘a*, Pā‘ā and Weliweli, suggests an early initial occupation within the Pā‘ā Ahupua‘a of circa A.D. 535 (Walker and Rosendahl, 1990:131). No coinciding early dates have been found within Kōloa Ahupua‘a, probably due to vagaries of sampling since most of the shoreline area of Kōloa had been heavily impacted by commercial, residential, and resort development. Initial occupation probably was characterized by temporary and/or recurrent occupation. From A.D. 600-1400, settlements in the Kōloa area were still limited to the coast. By A.D. 1040, lava tubes were used for burial and temporary habitation in the inland areas of Kōloa (Hammatt et al. 1999:7)

In the early historic era (1795-1880), the Kōloa Field System continued in use for foreign trade and was probably further intensified. Sweet potatoes were a main crop for the whaling and merchant ships, and the purchase of pigs, salt, oranges and other items are noted in many ship journals. The documents of the Great Māhele show that by the mid-1800s there were still several traditional farmers within Kōloa who both lived and worked within the area. The individual claims – for both *lo‘i* (wetland) and *kula* (dryland) suggest that while traditional farming of taro for subsistence was still taking place, in *kula* lands – sugar cane production for sale to the nearby sugar mill, had begun to dominate the landscape. Of the LCAs within Kōloa, several claim a *kula* planted with cane or a cane field or sugar cane garden. Several also identify cane lands as boundaries for the LCAs. Clearly, *kula* lands in the project area were being converted into sugar lands at an increasing rate. Within three years of sugar cultivation by Ladd and Company in 1835, residents in and surrounding Kōloa were quickly moving to adapt to the new economy based on the production of sugar cane. Eventually, most of inland Kōloa was planted with sugar cane and only the most rocky areas, unsuitable for cultivation, survived the dramatic changes in the landscape brought about during the early 20th century.

In the present project area, the ancient, heavily modified landscape known as the Kōloa Field System appears to be largely absent. Because habitation complexes, ceremonial sites, and irrigation systems have been located during archaeological surveys of nearby properties, the absence of these features within the present project area is cause for concern. It is possible that the ridge terrain above the present project area may have been too steep to effectively locate an ‘*auwai*, or, that architectural elements of existing ‘*auwai* and terraces associated with ‘*auwai* may have been scavenged to complete the construction of the irrigation flume support pylons. A small residential community is located immediately west of the project area on Hapa Road. Most residential lots are improved with low walls built of basalt cobble and small boulders. In addition, the close proximity of plantation-era and ranching-era basalt walls to the present project area indicates a concentrated use of basalt cobbles and boulders.

The current inventory survey has documented a historic plantation-era elevated metal irrigation flume consistent with previous findings within the Kōloa Ahupua‘a. Plantation-era remnants of railroad right-of-ways (O'Hare *et al* 2003), (Esh and Hammatt 2004) (Hill, Dockall and Hammatt 2005), irrigation culverts and flumes (Hammatt *et al* 1978), and laborer camps (Tulchin and Hammatt 2003), have been documented throughout the ahupua‘a of Kōloa, Weliweli and Pā‘ā. In successive stages of the cultivating process for sugar cane, more and more lands were cleared and subject to mechanical tilling and harvesting machines. The methods by which water was directed to the fields and mills, lands were cleared for cane, the routes railways and pack animals were designed to use: all these engineering methods were refined over time.

During an assessment survey of a 10.6-acre coastal parcel in Kōloa (Rohrer 2003), cultural sites and features associated with the Kōloa Field System were found to have been demolished due to the construction of a railroad right-of-way. The predictive model for TMK: (4) 2-8-15: 43, 44, and 82, located adjacent to the Sheraton Kaua‘i Resort Hotel, expected the continuation of a dense agricultural habitation complex inventoried north of Po‘ipū Road to extend into the project area. Only two pre-contact habitation sites were recorded following the assessment survey and the inventory survey of the project area.

Section 4 Results of Fieldwork

4.1 Survey Findings

Two possible pre-contact archaeological sites were located and identified within the project area during the inventory survey. Inventory survey team members stayed within visual distance of each other (approximately 10 meters apart). Two possible historic properties were identified from an earlier 2005 field inspection performed by Cultural Surveys Hawai'i, Inc., and relocated during the survey (Figure 11). CSH-1 was tested for subsurface archaeological deposits during archaeological work reported herein.

The inventory survey relocated a previously identified (Tulchin and Hammatt 2005) irrigation flume (SHIP 50-30-10-3926) constructed by the Koloa Sugar Company, and took measurements and photographs of the structure. The elevated flume had been dated to 1902 (Wilcox 1996), and it appeared that the structure had not been in use for over 50 years. The inventory survey revealed that damage had occurred to a 15-meter-long section of the irrigation flume from the modern operation of heavy equipment. It appeared that two of the structural pylons built of basalt cobbles and concrete had been leveled to grade at a point where the elevated metal flume met the concrete culvert under Hapa Road.

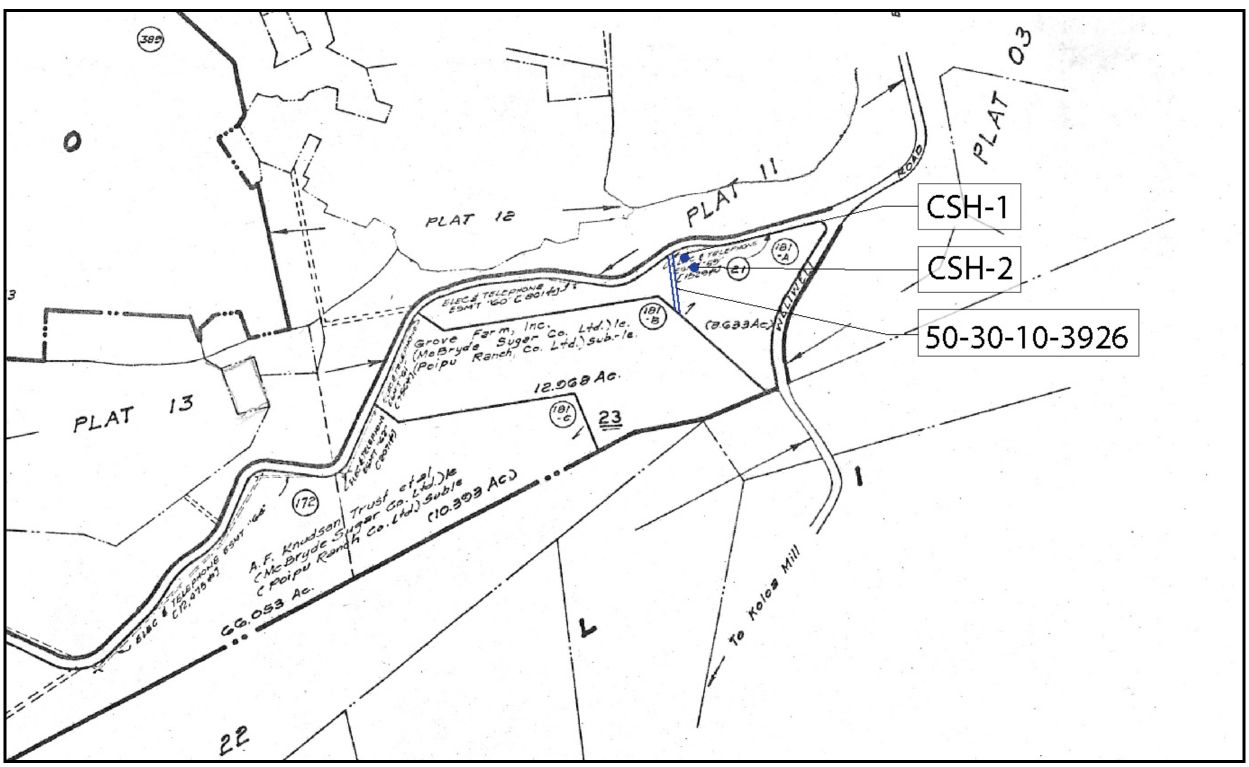


Figure 11. Location of CSH-1 and CSH-2, and path of the elevated metal irrigation flume (SHIP 50-30-10-3926). Weliweli Road is located right (north) of the project area and Hapa Road is located above (west) of the project area.

4.2 Site Descriptions

SITE:	**CSH-1**
FUNCTION:	PossibleTemporary Habitation
SITE TYPE:	Possible Raised Platform
TOTAL FEATURES:	1
DIMENSIONS :	2m by 2m
SIGNIFICANCE :	Not Historically Significant

Description: CSH-1 was initially classified as a possible raised platform located along the northwest boundary of the project area (See Figure 11) (Tulchin and Hammatt 2005). The feature consists of a concentrated mound of angular and subangular basalt, with a slightly larger area containing cobbles adjoining the mound on its’ south and east side. The mound was located atop a pahoehoe bedrock bluff which measured 90 centimeters (cm) tall. This bluff is aligned in a north to south direction, and consists of highly weathered basalt, which is a remnant of an intact pahoehoe flow. As the pahoehoe bluff was cleared in order to facilitate testing, it became apparent that CSH-1 was not a cultural remnant. The symmetery of the mounded basalt was due to the operation of a bulldozer, with the central portion of the “platform” the result of being scraped over the pahoehoe bluff in such a way as to duplicate a cultural feature (See Figure 12).

Figure 12. CSH-1: prior to excavation of TU#1. Note pahoehoe bluff 90cm above grade.

Testing Results :

A 1.0 meter by 0.5 meter Test Unit (TU#1) was placed and excavated in the center of the interior of the pahoehoe bluff within a thin soil layer (See Figure 13) of the possible raised platform, to test for the presence or absence of cultural deposits. The unit was excavated according to soil stratigraphy and terminated at 15 centimeters below the surface.

There was one stratigraphic layer present in this test unit.

Stratum I: (0-15 cmbs) A Horizon; 7.5YR 3/2, dark brown; fine, silt loam; weak, fine, crumb structure; loose dry consistency; non-plastic; no cementation; lower boundary was the top of pahoehoe bedrock. Organic matter, such as roots, rootlets, and humus were present in the thin soil layer which was excavated to the level of the pahoehoe bedrock. No cultural material was found in TU#1.

Figure 13. Left: Pre-Excavation. Right: Bottom of Excavation measured 15 cm Below Surface.

SITE: **CSH-2**
FUNCTION: PossibleTemporary Habitation
SITE TYPE: Possible Raised Platform
TOTAL FEATURES: 1
DIMENSIONS : 3m by 2m
SIGNIFICANCE : Not Historically Significant

Description: CSH-2 was initially classified as a possible raised platform located along the northwest boundary of the project area (Tulchin and Hammatt 2005). The feature consists of a concentrated mound of angular and subangular basalt, that resembles CSH-1 in morphology. The mound was located atop a pahoehoe bedrock bluff, which was cleared of vegetation in order that testing could be accomplished. Like CSH-1, CSH-2 was ascertained as bulldozer “push” mounded around a natural pahoehoe outcropping. No testing was pursued.

SITE: **50-30-10-3926**
FUNCTION: Irrigation
SITE TYPE: Plantation Flume
TOTAL FEATURES: 1
DIMENSIONS : 100m by 3m
SIGNIFICANCE : Criterion A

Description: SIHP Site 50-30-10-3926 is located within the center of the project area, and consists of an elevated plantation-era metal flume. The elevated metal flume feature is a well-preserved remnant of sugar cultivation ancillary support features constructed by The Koloa Sugar Company (Figure 14). The construction of the elevated metal flume within the project area was attributed to the Koloa Sugar Company in 1902 (Wilcox 1996), when approximately two and a half miles of concrete culvert and elevated metal flume were constructed to divert the flow of water from the Waikomo Stream to the reservoir at Kalaeokahonu.

The elevated metal irrigation flume within the present project area is classified as a “Lennon”-type, which refers to its overall design. The non-corrugated metal flume sections were fabricated from tin-covered steel sheets by blacksmiths in the field (Wilcox 1996). By the early 1900’s, corrugated and non-corrugated steel, manufactured by Armco Culvert & Flume Manufacturers Association, or Calco Iron Pipe, Ltd., was supplied to plantations in Hawai‘i. On a map dated 1918, drawn by Wright, Harvey and Wright, a concrete culvert is labeled “Cement Flume” (See Figure 15), and the section within the present project area is labeled “Metal Flume” (Conde 1973). On a U.S. Geological Survey map dated July, 1939, the direction of water flow within the metal flume sections is shown (Rosencrans 1939).

The construction of the elevated metal flume consists of the use of local basalt boulders and cobbles to create a series of concrete-and basalt pylons that maintain pairs of precast concrete forms with notches at an exact width of 177 cm. Each pair of notched pylons are designed to support 4-inch-thick redwood timbers cut to a height of 12-inches and in lengths of 16 feet. Each 16-foot section of redwood framework was bolstered by the use of 2 x 6 redwood or fir planking (See Figure 16).

Figure 14. Representative view of elevated plantation-era metal flume. View to the west.

Figure 15. View of concrete irrigation culvert at edge of Hapa Road. View to east.

For that portion of the elevated flume system within the project area, the average height above grade to the top of each pylon measured 2 meters (Figure 17). The exterior surfaces of each pylon were faced with natural basalt cobbles, and the top of each pylon was bedded with concrete to accommodate the precast concrete notch. Once the metal sections of flume were mounted within the redwood-beam framework, the weight of the water was supported by sets of iron wires (See Figure 18) bent into the same cross-section radius as the flume.

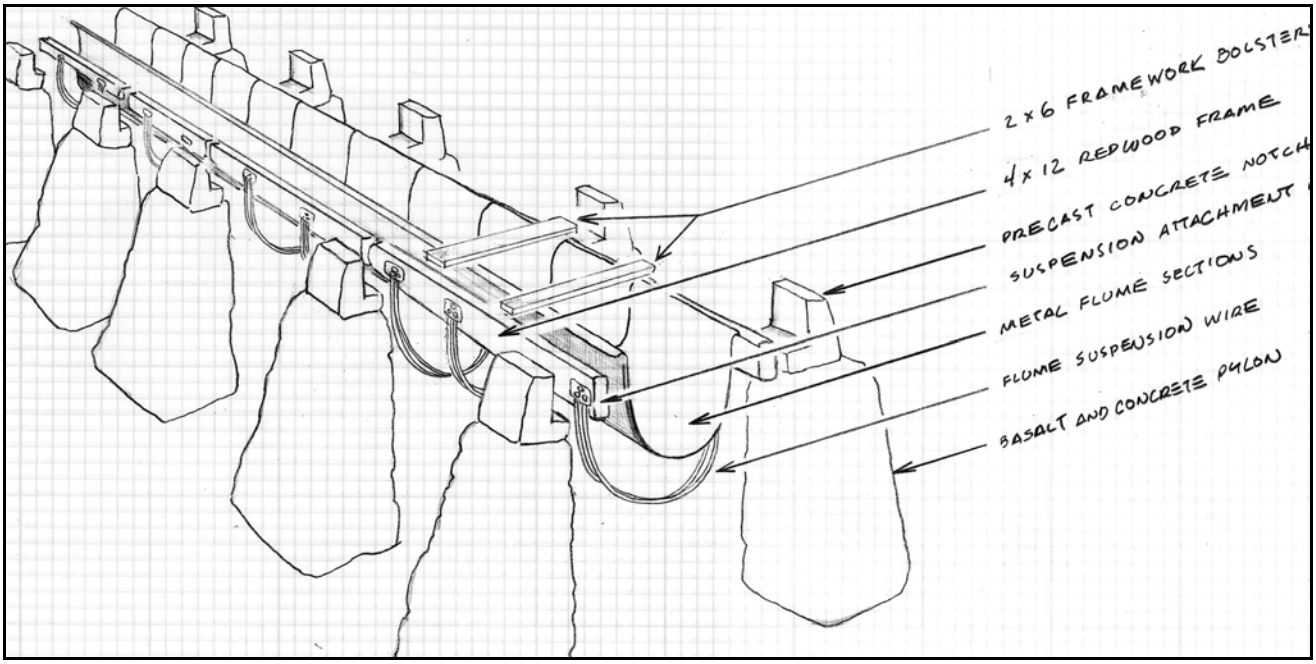


Figure 16. Exploded view of flume structure at Site 50-30-10-3926. (Not to scale)

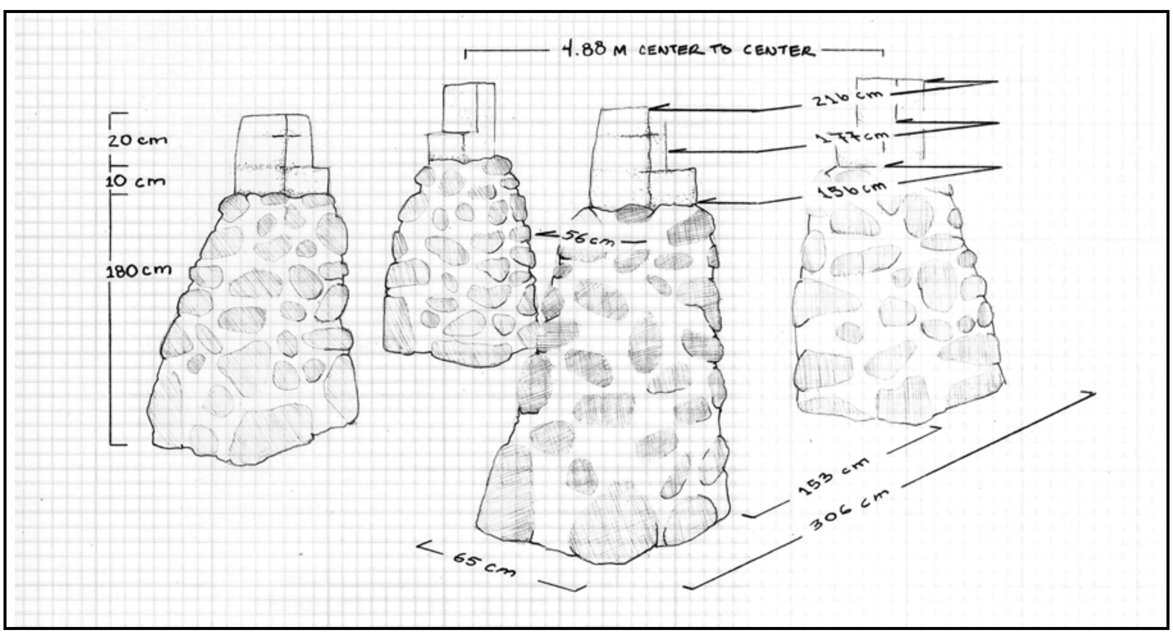


Figure 17. Height and width measurements of flume pylons at SHIP 50-30-10-3926. (Not to scale)

The use of 4 x 12 redwood timbers is noteworthy. The main structural redwood timbers had been cut dimensionally exact. The 4 x 12 beams measure out almost exactly (within 1/8th of an inch) at four inches thick by twelve inches high. Most of the bolster planking had been cut to "modern" standards. The 2 x 6 planks actually measured slightly under 1 5/8 by 5 1/2. Some bolstered sections had been built using dimensional lumber, which possibly was part of the original construction.

To complete the construction of the elevated flume, the metal sections were crimped together, bound with sets of the suspension wire, bolted to the wooden framework, and painted with tar to prevent excessive leakage of water. The completed structure (See Figure 19) allowed the height of the flume to maintain a set elevation over rough terrain.

The method by which the metal flume system was engineered gives a clear idea that the use of the metal flume system found in the present project area probably ended with the modernization of the Koloa Sugar Company. When the Grove Farm Company purchased the Koloa Sugar Company in 1948, economies of scale were changed. The Grove Farm Company tapped more economical sources for water, thus negating the need for the Waikomo Stream as a source for water as far away as Pāʻā (Wilcox 1996).

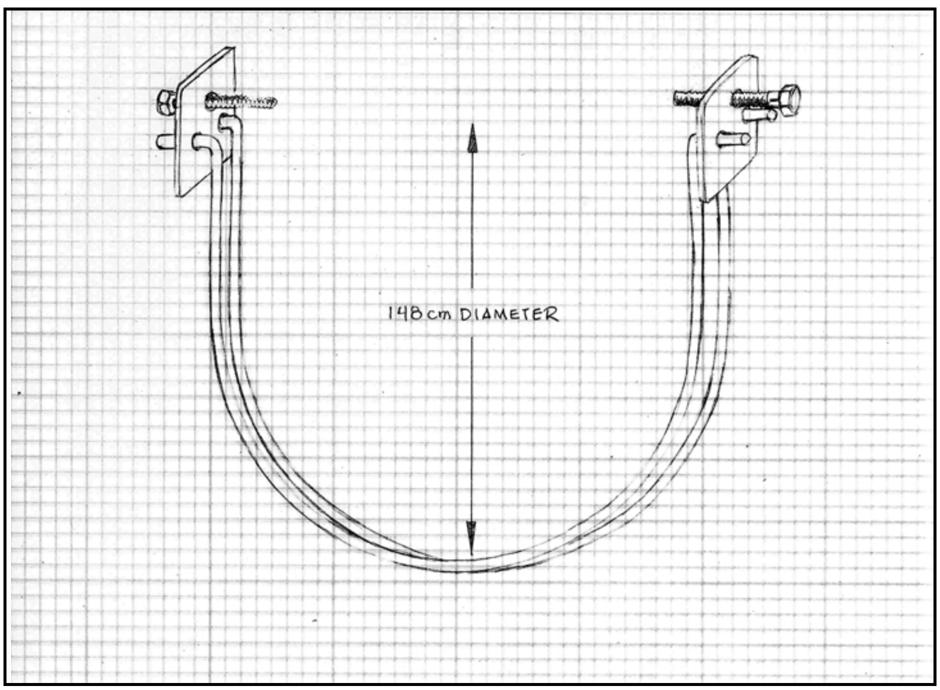


Figure 18. Flume suspension wire set including metal cleat and lag bolt detail. (Not to scale)

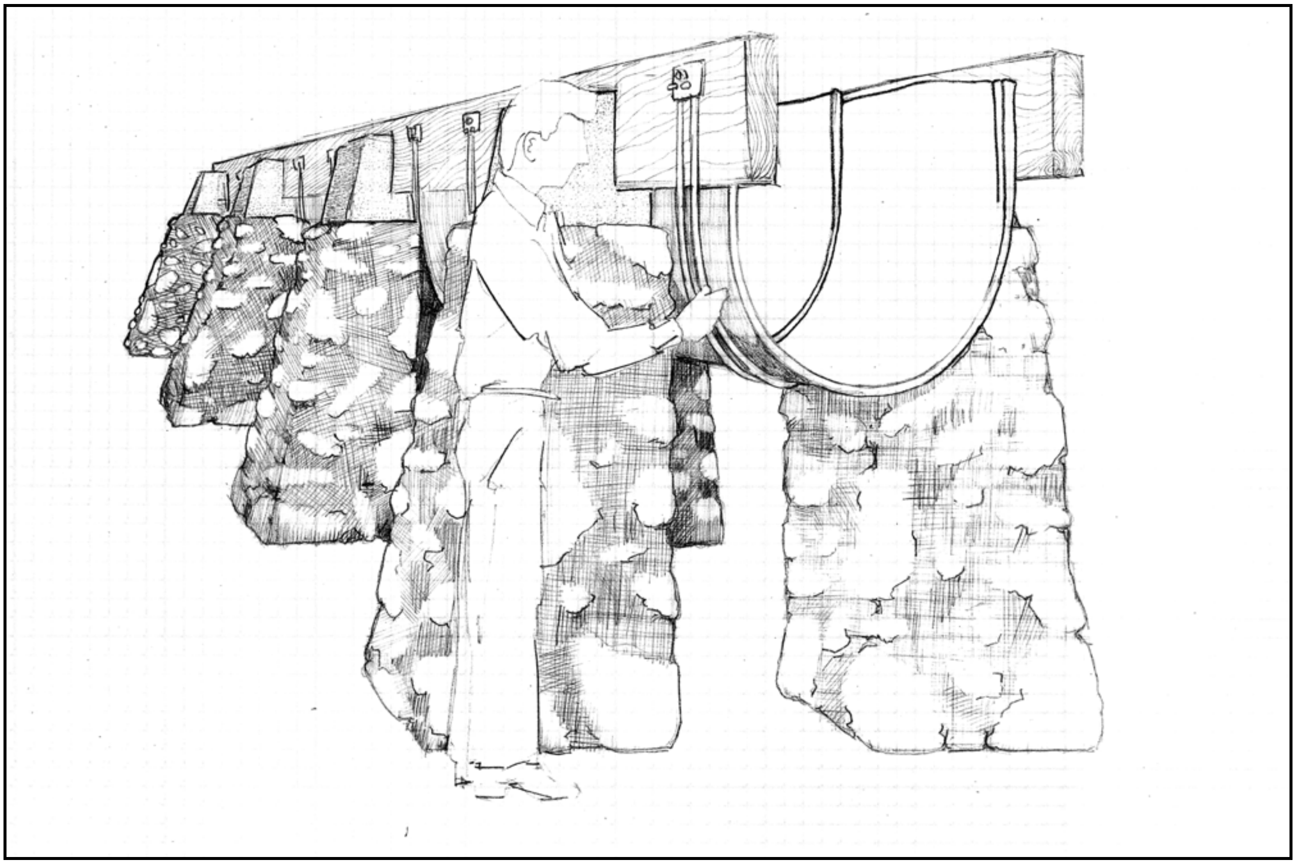


Figure 19. Concept drawing of completed flume structure. (Not to scale).

4.3 Test Excavations Findings

The inventory survey included the excavation of one test unit (TU#1) within the central portion of one (CSH-1) of the two sites interpreted as being raised platform remnants. The excavation unit location was selected based on the potential to yield archaeological information.

CSH-1 was tested by placing a 0.5 by 0.5 meter test unit (TU#1) in the central portion of the basalt cobble mound at the top of the pahoehoe bluff. There was one stratigraphic layer present in this test unit. Bedrock formed the base of the excavation at 15 centimeters. No cultural material was found.

CSH-2 was not tested.

SIHP Site 50-30-10-3926 was not tested

Section 5 Summary and Interpretation

5.1 Summary

A review of historic documentation indicates that the upland areas of Kōloa Ahupuaʻa were carefully developed for agriculture during the pre-contact/early post-contact period.

Initial occupation of this portion of Kauaʻi, in the neighboring *ahupuaʻa* of Paʻa, may have taken place as early as A.D. 535 (Walker and Rosendahl, 1990:131). From A.D. 600 to A.D. 1400, settlements were limited to the coast. By A.D. 1450, dispersed housing and field shelters were set up in the inland areas adjacent to fields (McMahon 1989). Work at the Sheraton Kauaʻi Resort grounds in 1996-1998 uncovered a cultural deposit with fire pits and habitation structures, providing evidence of habitation along the Kōloa coast. Other archaeologists (Bennett 1931; Kikuchi 1963, 1979, and Hammatt 1990, 1992) have found field shelters and lava tubes used for habitation in the nearshore portion of the area now developed as the Sheraton Kauaʻi Resort Hotel (TMK (4) 2-8-16:3,4,11, and 12).

By A.D. 1450, the Kōloa Field System, an intense network of taro fields irrigated by *ʻauwai* branching from Waikomo Stream, was in place (McMahon 1989). Other upland areas were cultivated with small patches of sweet potato and other plants. In the post-contact period, the planting of sugar cane, pumpkins, Irish potatoes, and other crops that could be traded to merchants and whalers, were added or superseded the Polynesian crops. Although the sugar cane fields of the Koloa Sugar Company, established in 1835, did not extend into the nearshore coastal areas, these coastal areas nonetheless had been disturbed by post-contact use. In the case of the present project area, the cultivation of taro and other traditional crops in the area east of Kōloa town appears to have given way to sugar and pasture land. Traditional agricultural features, such as terraces and mounds, were found in parcels south of the present project area, but were also found to have been disturbed (Hammatt 1991). According to the LCA descriptions for lands located within and adjacent to the present project area, an *ʻauwai* appears to have been used as a boundary between the three parcels. During the current survey, the use of the project area by the Koloa Sugar Company to site a modern irrigation flume appears to have cleared away any vestige of the traditional cultural practices of taro farming.

Salt manufacture was an important activity in the coastal areas, according to historic documents. Bennett (1931) recorded several large ponds along the Kōloa Coast. These ponds were divided by long walls to form shallow sections, in which salt could be precipitated. There are several ornamental ponds on the Sheraton Kauaʻi Resort grounds; these all have concrete bottoms. Although these ponds could have been built over existing ponds, the construction of the ornamental pools probably heavily damaged or destroyed the original surface constructions and subsurface layers. There are still several small salt pans, bait cups, and abraded areas on the pahoehoe headlands at the southern boundary of the Sheraton Kauaʻi Resort project area (O'Hare 2003).

During the present inventory survey, two probable archaeological sites: CSH-1 and CSH-2, initially classified as raised platforms, were relocated from an earlier assessment. CSH-1 was tested and found to have been a geologic feature modified by heavy machinery. CSH-2 was determined to have been similar in nature to CSH-1, and was not tested. A third site, SIHP 50-

30-10-3926, the elevated metal irrigation flume, was located immediately south of CSH-1 and CSH-2. SIHP Site -3926 consisted of 19 pairs of basalt and concrete pylons constructed to suspend an irrigation flume 1 meter above the ground on its path across the project area. No test excavation was performed within the flume right-of-way. The methods by which the flume was constructed, the amount of damage displayed within the structure, and the methods by which repairs were effected on the structure suggested that the flume had not been used for approximately 50 years. A modern cattle trough was also noted northeast of the flume. Both CSH-1 and CSH-2, as well as SIHP Site -3926 were documented with photographs, descriptions and GPS positioning data.

5.2 Site Summary Interpretation

Pedestrian survey of the 8.633-acre parcel confirmed the use of heavy equipment that had highly modified the project area. Bulldozers had cleared areas, and in the process, had created "push-piles of debris which simulated some aspects of traditional agricultural features. In addition, transects located closest to Weliweli Road were characterized by uneven areas of basalt boulder fill related to the original construction of Weliweli Road. Transects along Hapa Road were hampered by modern barbed wire enclosures and stored derelict vehicles, although the property itself had previously been cleared and leveled. Any archaeological sites within these areas may have been damaged to the point of non-recognition.

West of the subject parcel, a concrete irrigation culvert constructed by the Koloa Sugar Company carried water to a point under Hapa Road. The elevated metal irrigation flume (SIHP Site -3926) was designed to couple to the concrete culvert on the eastern edge of Hapa Road. The flume carried irrigation water across the project area to a point where the flume then exited the project area midway along its eastern boundary. East, and outside of the subject parcel, a separate feature of the irrigation system appeared to divert water from the flume, and channel the water into a pipeline.

No State Inventory of Historic Places (SIHP) site numbers were assigned to CSH-1 or CSH-2 during this archaeological inventory survey. These sites were investigated as possible raised platforms. Testing established that no traditional cultural materials were present within CSH-1. Testing for CSH-2 was abandoned.

Site 50-30-10-3926, within the project area, was found to be associated with the expansion of sugar plantation lands of the Koloa Sugar Company. By 1900, sugar operations included the acquisition of lands in Mahaʻulepu. Water from the Waikomo Stream was needed to supply a reservoir in Kalaeokahonu, and the flume was constructed in 1902 as part of that expansion.

The results of the current inventory survey of the project area generally conform to most of the expectations derived from the historical and archaeological background research. The pre-contact settlement pattern predicted for this area was one of intensive farming. According to the predictive model for the upland areas of Kōloa, "The individual claims – for both *loʻi* (wetland) and *kula* (dryland) suggest that while traditional farming of taro for subsistence was still taking place, in *kula* lands – sugar cane production for sale to the nearby sugar mill, had begun to dominate the landscape ." Although archaeological evidence of the Kōloa Field System undoubtedly existed within the project area at one time, modifications to accommodate the construction of the elevated irrigation flume cleared any such evidence away.

The results of testing within the raised platform area of CSH-1 (TU#1) confirmed both the high level of surface modification within the project area, and that the extent of clearance operations included the entire parcel. Preparation of the land prior to construction of the elevated metal irrigation flume, and the continued maintenance of the flow of water within the flume, are conditions that caused the complete destruction of any features of the Kōloa Field System.

Section 6 Significance Assessments

Significance assessments of historic properties are developed in accord with the following criteria as set forth in the Code of Federal Regulations, Title 36, Part 60. The specifics of each criterion are provided below:

A. Sites that are associated with events that have made a significant contribution to broad patterns of our history; or

B. Sites that are associated with the lives of persons significant in our past; or

C. Sites that embody the distinctive characteristics of a type, period, or method of construction, or that represents the work of a master, or that possesses high artistic values, or that represents a significant or distinguishable entity, whose components may lack individual distinction; or

D. Sites which have yielded, or may be likely to yield, information important in prehistory or history.

A fifth criterion is included that has been developed for the State of Hawaiʻi Register of Historic Places as set forth in Hawaii Revised Statutes 13-275-6.

E. Sites which have an important value to the native Hawaiian people or to another ethnic group of the State due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events, or oral accounts- these associations being important to the groups' history and cultural identity.

The significance assessment for each site recorded within the project area or that could be potentially negatively impacted by project development is provided in Table 2. The elevated metal flume (SHIP Site –3926) is deemed significant according to Criterion A due to its association with the construction of the infrastructure of the Koloa Sugar Company, and it is also deemed significant according to Criterion D: for engineering information regarding the construction of the flume. Although the elevated metal flume is considered significant under Criterion A, the construction methods employed by the Koloa Sugar Company appear to have been common. The use of the elevated metal irrigation flume is the most cost-effective method by which ditches of disparate heights are connected to each other.

Table 2. Site Significance Table for Sites CSH-1, CSH-2 and SHIP 50-30-10-3926.

State Site No. (SHIP 50-30-10-)	CSH No.	Number of Features	Function	Significance Criteria
none	CSH-1	1	Recently Modified Natural Feature	none
none	CSH-2	1	Recently Modified Natural Feature	none
50-30-10-3926		1	Irrigation Flume	A, D

A field map dated 1918, and maintained by the Pioneer Mill Company of Lahaina, Maui, shows approximately 1.78 miles of elevated metal flumework connecting the large mountain ditches of Honokohau with reservoirs in the upland areas of Launiopoko, Kauaʻula, and Kahana. The Hutchinson Sugar Plantation Company of Naalehu, Hawaiʻi, lists 6,855 linear feet of metal flume, ranging in diameter from 9.5 inches to 26.8 inches. In this regard, the records of the Koloa Sugar Company list the linear length of metal flume built as 6,367 feet, ranging in diameter from 26.8 inches (68.07 cm) to 107 inches (271.78 cm).

By 1920, almost every sugar plantation in Hawaiʻi used elevated metal flumes, in addition to ditches, tunnels, pipelines, siphons, wells, and dams (See Table 3). Elevated metal flumes were the standard method by which gullies were traversed. The Ewa Plantation on Oʻahu utilized 8.9 miles of the elevated metal flume of the same type (Lennon-type: from sheet metal manufactured by Armco) used by the Koloa Sugar Company. The Lihue Plantation on Kauaʻi listed over 4,000 linear feet of metal flume used primarily to cross gullies. On the island of Hawaiʻi, most of the plantations located along the Hamakua coastline used the abundant rainfall to "flume" harvested cane stalks to the mills. The Olaa Plantation used over 12 miles of metal flume, in diameters that varied between 30 and 46 inches, to transport bundles of cane directly to their mill.

Table 3. List of Metal Flume and Metal Pipe Used at Each Plantation in Hawaiʻi (Gilmore 1936).

Plantation	Irrigation	Detail of Metal Irrigation Features
Oʻahu		
Ewa Plantation	Artesian Well	Lennon type 8.9 miles, Ewa type 7.89, German iron 12.33.
Honolulu Plantation	Well	4.5 miles of metal pipe
Kahuku Plantation	Well	3 miles of metal pipe
Oahu Sugar Co.	Mountain/Well	0.8 miles of iron flume/ 10.85 miles of metal pipe
Waialua Ag. Co.	Mountain/Well	2.7 miles metal flume, 13.4'-76.4" diameter
Waianae Company	Mountain/Well	9.85 miles of metal flume, 12'-34" in width
Waimanalo Sugar	Mountain/Well	0.42 miles of cast iron pipe
Kauaʻi		
Grove Farm Co.	Mountain	3-4 miles of cast iron pipe
Hawaiian Sugar	Mountain	1.1 miles of metal pipe
Kekaha Sugar Co.	Mountain/Well	1 mile of metal pipe
Plantation	Irrigation	Detail of Metal Irrigation Features
Kilauea Sugar Co.	Mountain	1,581 feet of Armco Lennon-type metal flume, 53.5"-84" dia.
Koloa Sugar Co.	Mountain	6367 feet of metal flume, 26.8"-107"in diameter
Lihue Plantation	Mountain	1988 feet of metal flume, 45.8"-76.4 " in diameter
McBryde Sugar	Mountain/Well	Information not available
Waimea Sugar	Mountain/Well	Information not available
Maui		

Plantation	Irrigation	Detail of Metal Irrigation Features
HC&S Co., Ltd.	Mountain/Well	10.77 miles of steel pipe
Kaeleku Sugar Co.	Rain	No irrigation system
Maui Ag. Co. Ltd.	Mountain/Well	2860 feet of steel pipe
Pioneer Mill Co.	Mountain/ Well	1.78 miles of metal flume, 19.1”-76.4” in diameter
Wailuku Sugar Co.	Mountain	3168 feet of metal flume, 15.3”-61.1” in diameter
Hawai‘i		
Hakalau Plantation	Rain	No irrigation system
Hamakua Mill Co.	Rain	No irrigation system
Hawaiian Ag. Co.	Rain	6944 feet of metal flume carries field water to the mill
Hilo Sugar Co.	Rain	No irrigation system
Honokaa Sugar Co.	Rain/Mountain	0.5 miles of metal pipe
Honomu Sugar Co.	Rain	No irrigation system
Hutchinson Sugar	Rain	6855 feet of metal flume, 9.5”-26.8” in diameter
Kaiwiki Sugar Co.	Rain	No irrigation system
Kohala Sugar Co.	Mountain/Well	Kohala and Kehena Ditch Systems use no metal flumes
Laupahoehoe Sugar	Rain	3566 feet of metal pipe
Olaa Sugar Co.	Mountain	12 miles of metal flume, 30”-46” in diameter
Onomea Sugar Co.	Rain	No irrigation system
Paauhau Sugar Co.	Mountain	Irrigation system does not utilize metal flumes or pipes
Pepeekeo Sugar Co.	Rain	No irrigation system
Union Mill	Mountain	Irrigation system does not utilize metal flumes or pipes
Waiakea Mill Co.	Rain	8 miles of flume is not designated wood or metal
Wailea Milling Co.	Rain	16 miles of flume is not designated wood or metal

Section 7 Project Effect and Mitigation Recommendations

7.1 Project Effect

The proposed development project would have a negative effect upon subsurface historic properties that could be located within the proposed development area as well as a negative effect upon such properties that are closely adjacent. Negative effects to adjacent areas could be related to equipment staging and other construction-related activities.

7.2 Mitigation Recommendations

No mitigation recommendations affect the present project area. The project area north of the elevated metal irrigation flume includes topography that may include such geologic features as lava tubes. Although there may be a potential for the discovery of cultural deposits north of the elevated metal irrigation flume, please note that no mitigation recommendation has been made for the flume feature itself. All project area historic properties are listed below in table form.

7.2.1 No Further Work.

All features associated with Sites CSH-1, CSH-2 and SHIP 50-30-10-3926 have been thoroughly documented. Cultural Surveys Hawai‘i, Inc., recommends that no further work is necessary in regard to these three sites. This conclusion is based on the decision that Sites CSH-1 and CSH-2 consist entirely of modern surface modifications to pahoehoe bluffs. The context by which cultural materials may have been observed within the project area has been extensively compromised during the construction and maintenance of the elevated metal irrigation flume, as well as the modern construction of roadways bordering the project area. In regard to SHIP 50-30-10-3926, data recovery has been concluded for the flume feature.

Table 4. Mitigation Recommendations

Site No.	Recommendations	Comments
-3926	No further work required.	Inventory survey complete.
CSH-1	No further work required.	Inventory survey complete.
CSH-2	No further work required.	Inventory survey complete.

7.2.2 Archaeological Monitoring

Within the 160-acre parcel (TMK (4) 2-9-13: portion 1, and TMK: (4) 2-8-14: portion 1,3,19) known as the Po‘ipulani Development Area, located directly south of the present project area, Cultural Surveys Hawai‘i, Inc., conducted an inventory survey which identified 75 historic properties consisting of approximately 98 separate features. This survey (Hammatt, Folk and

Stride 1991) established that the potential exists for additional archaeological sites to be uncovered within the present project area during grubbing and grading.

An archaeological monitor is not recommended during the initial phases of excavation and grading of the subject parcel. If in the unlikely event that any human remains or other significant subsurface deposits are encountered during the course of any development activities, all work in the immediate area should stop, and the Hawaii State Historic Preservation Division should be promptly notified.

It is further recommended that all construction personnel review the proper procedures for halting work, notification of the proper authorities, and protection of cultural remains prior to the commencement of any grubbing and grading work. The potential for significant findings within geologic structures such as lava tubes exists in the uplands of Kōloa, and the need for caution in this regard is therefore stressed.

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2005b *Archaeological Inventory Survey of an Approximately 25-Acre Parcel at Kōloa Ahupuaʻa, Kona District, Kauaʻi*, TMK: (4) 2-18-15: 25-37 and 45-74, Cultural Surveys Hawaiʻi, Inc., Kailua, Hawaiʻi.

Appendix F

Archaeological Inventory Survey of an Approximately 2.8-Acre Knudsen Trust Parcel Kōloa Ahupua‘a, Kona District, Island of Kauai TMK: (4) 2-8-013:001 por.

Prepared for

Eric A. Knudsen Trust

Prepared by

Todd Tulchin, B.S.

and

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai‘i, Inc.

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(Job Code: KOLO 50)

December 2005

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Management Summary

Report Reference	Archaeological Inventory Survey of an Approximately 2.8-Acre Knudsen Trust Parcel, Kōloa Ahupuaʻa, Kona District, Island of Kauaʻi (TMK: (4) 2-8-013:001 por.) (Tulchin and Hammatt 2005)
Project Number	KOLO 50
Location	The project area is located adjacent to Hapa Rd., approximately 0.6 mi (1 km) southeast of Kōloa Town, Kōloa Ahupuaʻa, Kona District, Island of Kauaʻi (TMK: (4) 2-8-013:001 por.). The project area is depicted on the USGS 1:24,000 Topographic Map Koloa Quadrangle (1996)
Date Submitted	December 2005
Permit Number	Cultural Surveys Hawaiʻi Inc. (CSH) completed the fieldwork component of the archaeological inventory survey under Hawaiʻi State Historic Preservation Division (SHPD) permit No. 0508, per Hawaiʻi Administrative Rules (HAR) Chapter 13-13-282.
Agencies	State Historic Preservation Division
Land Jurisdiction	The subject parcel is privately owned by the Eric A. Knudsen Trust.
Survey Acreage	2.851-acres
Development Project Description	Proposed development within the subject parcel included subdivision of the entire parcel for residential houselots. Minimally, land disturbing construction would include grubbing, grading, dwelling construction, and excavations for the installation of subsurface utilities.
Historic Preservation Regulatory Context	At the request of the Eric A. Knudsen Trust, CSH conducted this archaeological inventory survey. In consultation with SHPD, the inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276 and Chapter 13-13-284.
Field Effort	Fieldwork was accomplished on August 2-4, 2005, by Todd Tulchin, B.S., Robert Hill, B.A., and Hallett H. Hammatt, Ph.D., and required 6 person-days to complete. Fieldwork consisted of a 100% coverage pedestrian inspection and limited subsurface testing.

Historic Properties Identified	Three historic properties, comprised of six component features, were identified within the project area. State Inventory of Historic Properties (SIHP) No. 50-30-10-3923 Features A-C (series of stone walls), 50-30-10-3924 (platform), and 50-30-10-3925 Features A and B (agricultural planting areas).
Site Significance Evaluations	SIHP# 50-30-10-3923 Features A-C (series of stone walls), 50-30-10-3924 (platform), and 50-30-10-3925 Features A and B (agricultural planting areas) are evaluated as being significant under Criterion D (have yielded, or may be likely to yield information important in prehistory or history) of the State and National Register of Historic Places.
Area of Potential Effect (APE)	The project's APE is defined as the entire 2.851-acre project area. The proposed single-family home construction poses no additional auditory or visual impact to any surrounding potential historic properties.
Effect Recommendations	The proposed residential houselot development project will adversely affect three significant historic properties (i.e. SIHP# 50-30-10-3923, -3924, and -3925) located within the project's APE. CSH's project specific effect recommendation is "effect, with mitigation commitments." The recommended mitigation measures will reduce the project's adverse effect to these significant historic properties.
Mitigation Recommendations	The following significant historic properties will be adversely affected by the proposed project. The recommended mitigation measures listed below are intended to alleviate this adverse effect. SIHP# 50-30-10-3923 (stone walls): No Further Work. Sufficient data generated by the current study. SIHP# 50-30-10-3924 (platform): Archaeological Data Recovery Program. SIHP# 50-30-10-3925 (agricultural planting areas): Archaeological Data Recovery Program.

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Section 1 Introduction

1.1 Project Background

At the request of the Eric A. Knudsen Trust, Cultural Surveys Hawaiʻi Inc. (CSH) conducted an archaeological inventory survey of an approximately 2.8-acre parcel in Kōloa Ahupuaʻa, Kona District, Island of Kauaʻi (TMK: (4) 2-8-013:001 por.). In consultation with the Hawaiʻi State Historic Preservation Division (SHPD), the inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276 and Chapter 13-13-284. CSH completed the fieldwork component of the archaeological inventory survey under SHPD permit No. 0508, per Hawaiʻi Administrative Rules (HAR) Chapter 13-13-282.

The project area is located adjacent to Hapa Road, approximately 0.6 mi (1 km) southeast of Kōloa Town (Figures 1-2). The subject parcel is privately owned by the Eric A. Knudsen Trust. At the time of the inventory survey, the land was not being actively utilized. Proposed development within the subject parcel included subdivision of the entire parcel for residential houselots. Minimally, land disturbing construction would include grubbing, grading, dwelling construction, and excavations for the installation of subsurface utilities.

1.2 Scope of Work

The archaeological inventory survey and its accompanying report documented all historic properties within the subject parcel. The following scope of work satisfies State and County requirements for an archaeological inventory survey [per HAR 13-13-276]:

1. A complete ground survey of the entire project area for the purpose of site inventory. All sites were located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation included photographs and scale drawings of selected sites and complexes. All sites were assigned State Inventory of Historic Properties (SIHP) numbers.
2. Limited subsurface testing was conducted to determine if subsurface deposits were located in the project area (particularly in archaeological sites), and, if so, evaluate their significance. Appropriate samples from these excavations were found and analyzed for chronological and paleoenvironmental information.
3. Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research focused on the specific area with general background on the *ahupuaʻa* and district and emphasized settlement patterns.
4. Preparation of this inventory survey report included the following:
    a. A topographic map of the survey area showing all archaeological sites and site areas;
    b. Description of all archaeological sites with selected photographs, scale drawings, and discussions of function;

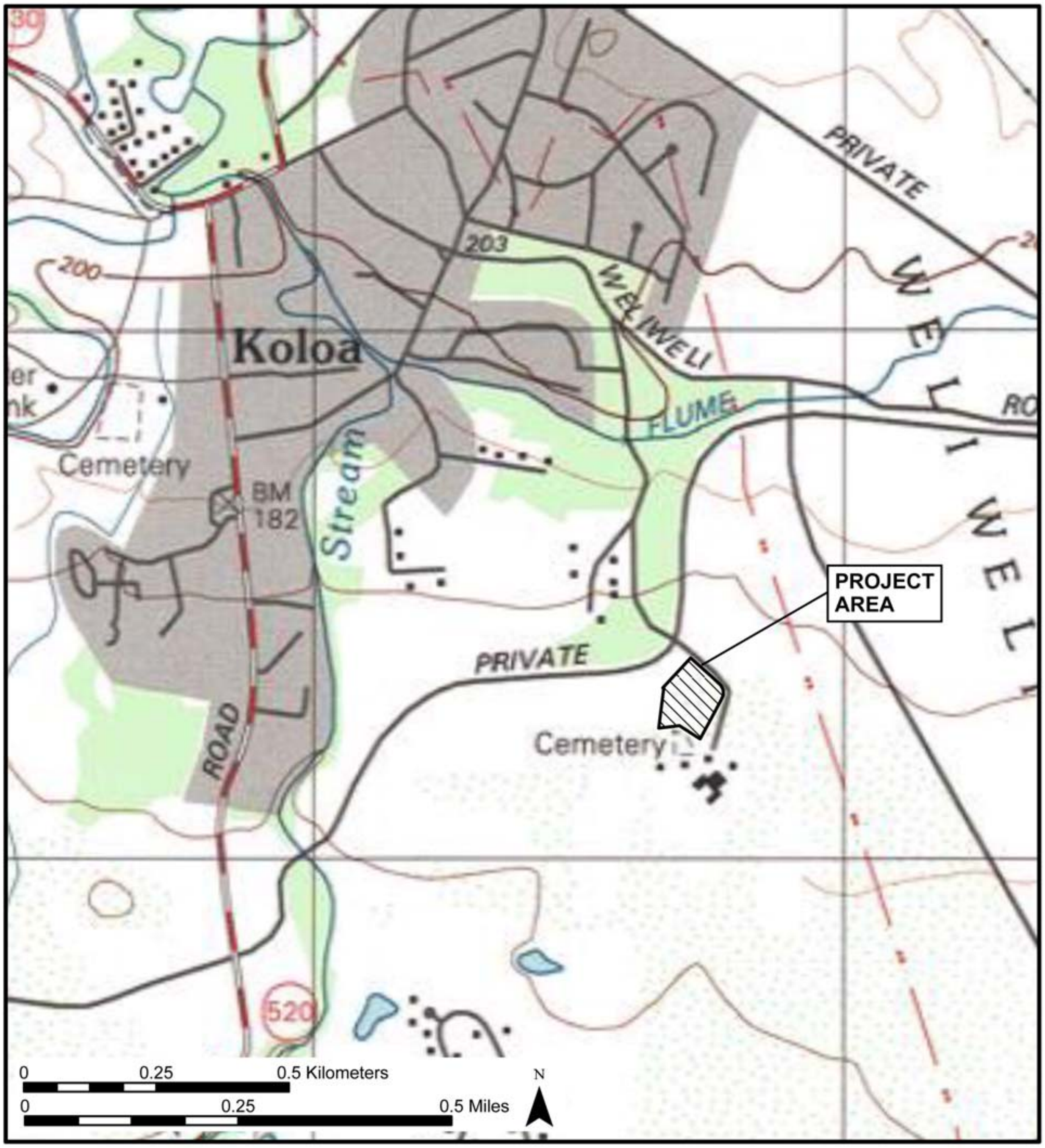

Figure 1. USGS Topographic Map, Kōloa Quadrangle (1996), showing the location of the project area.

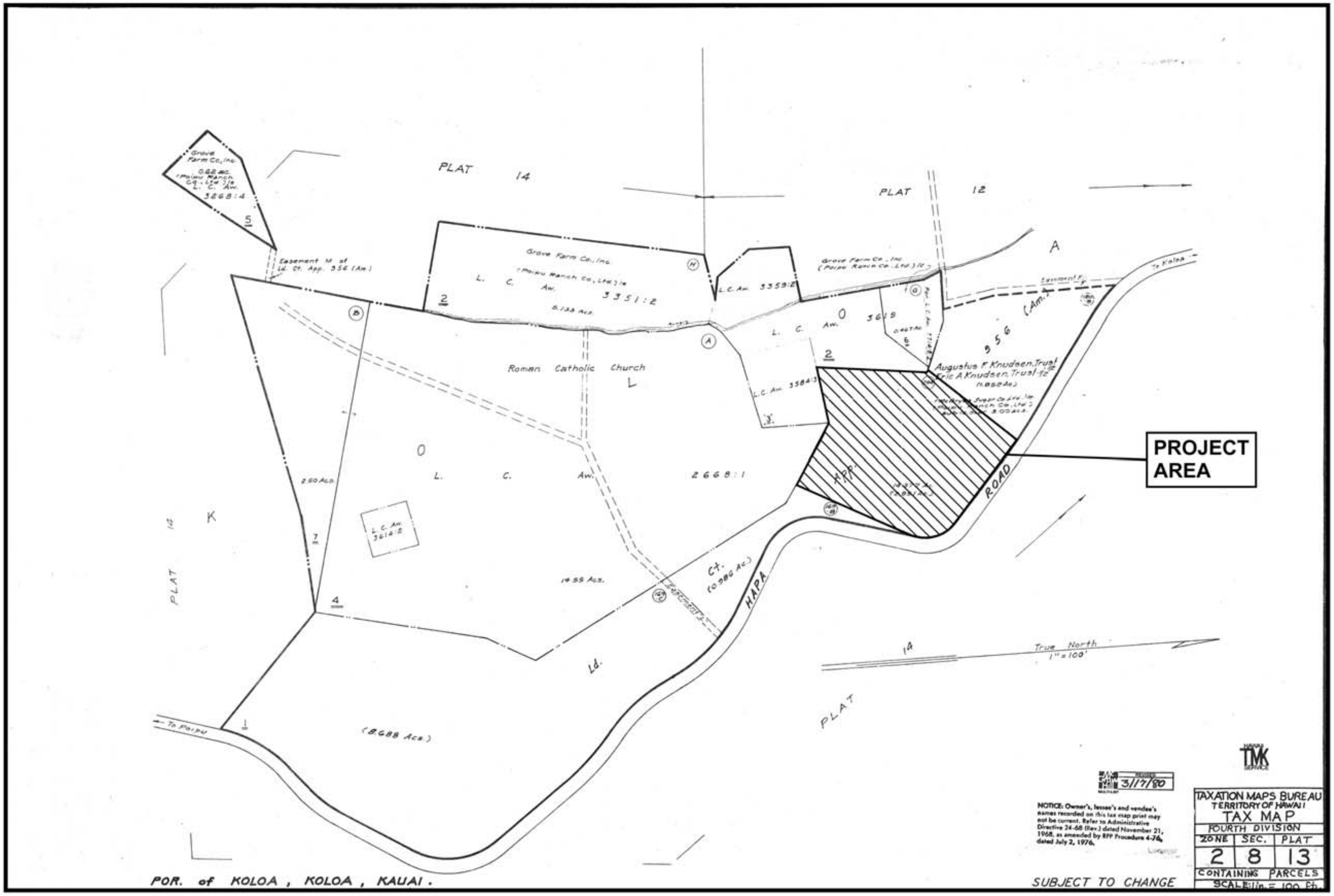

Figure 2. TMK 2-8-13, showing the location of the project area.

c. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the archaeological features;

d. A summary of site categories and their significance in an archaeological and historic context;

e. Recommendations based on all information generated that will specify what steps should be taken to mitigate impact of development on archaeological resources - such as data recovery (excavation) and preservation of specific areas. These recommendations will be developed in consultation with the client and the State agencies.

This scope of work also includes full coordination with the State Historic Preservation Division (SHPD), and County relating to archaeological matters. This coordination takes place after consent of the owner or representatives.

1.3 Environmental Setting

1.3.1 Natural Environment

The project area is located within relatively level terrain, at an elevation of approximately 150 ft. (46 m) a.m.s.l.. The project area receives approximately 1400mm (55 in.) of annual rainfall (Giambelluca et al. 1986). Vegetation within the project area consisted primarily of *koa haole* (*Leucaena leucocephala*) and exotic weeds, vines, and grasses. Additional species included sisal (*Agave sisalana*), autograph tree (*Clusia rosea*), banyan (*Ficus spp.*), and night-blooming cereus (*Cereus spp*.).

Soils within the project area are listed as Waikomo extremely rocky silty clay (Wu) and Waikomo very rocky silty clay (Wt) (Foote et al. 1972). Soils of the Waikomo Series consist of "well-drained, stony and rocky soils on uplands on the island of Kauai…developed in material weathered from basic igneous rock, probably with a mixture of ash and alluvium in places" (Foote et al. 1972). In general, the soil layer appeared to be relatively thin, with many areas of exposed pahoehoe bedrock.

1.3.2 Built Environment

The subject parcel was undeveloped at the time of the inventory survey. No modern structures or infrastructure were located within the project area. Lands to the west of the subject parcel were also undeveloped at the time of the inventory survey. The asphalt-paved Hapa Road borders the northern and eastern portions of the project area. The St. Raphael Roman Catholic Church grounds and cemetery border the southern portion of the project area.

Section 2 Methods

2.1 Field Methods

Fieldwork was accomplished on August 2-4, 2005, by Todd Tulchin, B.S., Robert Hill, B.A., and Hallett H. Hammatt, Ph.D., and required 6 person-days to complete. Fieldwork consisted of a 100% coverage pedestrian inspection and limited subsurface testing. The pedestrian inspection of the project area was accomplished through systematic sweeps. The interval between the archaeologists was generally 5-10 m. All historic properties encountered were recorded and documented with a written field description, site maps, photographs, and each site was located using Trimble GPS survey technology.

Subsurface testing consisted of the partial excavation, by hand, of selected surface archaeological features located during the pedestrian survey. The purpose of the subsurface testing was to determine the function of located surface sites as well as to possibly obtain datable materials for later radiocarbon dating. All material excavated from the test unit was sifted through an 1/8 in. wire mesh screen to separate out the soil matrix, then all cultural material was collected for analysis in the lab. Each test excavation was documented with a scale section profile, photographs, and sediment descriptions. Sediment descriptions included characterizations of Munsell color designations, compactness, texture, structure, inclusions, cultural material present, and boundary distinctness and topography.

2.2 Laboratory Methods

Laboratory analyses of material recovered from limited subsurface testing within the project area included:

1. Preparation and submittal of datable material, such as charcoal, to Beta Analytic for radiocarbon AMS dating.
2. Identification of invertebrate midden. Common marine shells were identified and analyzed at the Cultural Surveys Hawaiʻi laboratory in Kailua, Hawaiʻi.
3. Identification of vertebrate faunal material. All vertebrate faunal material was identified and analyzed at the Cultural Surveys Hawaiʻi laboratory in Kailua, Hawaiʻi.
4. Identification and cataloguing of traditional Hawaiian artifacts. Any artifacts collected *in situ* at the project area or contained within sediment samples was measured, weighed and classified by material type and artifact type. The analysis then focused on distinguishing the possible function of the artifact.

2.3 Document Review

Historic and archival research included information obtained from the UH Hamilton Library, the State Historic Preservation Division Library, the Hawaiʻi State Archives, the State Survey Office, and the Archives of the Bishop Museum. Previous archaeological reports for the area were reviewed, as were historic maps and primary and secondary historical sources. Information on Land Commission Awards was accessed through Waihona Aina Corporation's Māhele Data Base (<www.waihona.com>).

2.4 Consultation

Consultation with knowledgeable local informants was made as part of an accompanying Cultural Impact Assessment conducted by Cultural Surveys Hawai‘i, Inc for the Village at Po‘ipū project area (Mitchell et al. 2005). The Village at Po‘ipū lands included the current project area. Hawaiian organizations, agencies and community members were contacted in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the project area and the vicinity. The organizations consulted included the State Historic Preservation Division (SHPD), the Office of Hawaiian Affairs (OHA), the Kaua‘i/Ni‘ihau Islands Burial Council, the Kaua‘i Historic Preservation Review Commission, and Hui Malama I Nā Kūpuna O Hawai‘i Nei.

Through the consultation process, it was ascertained that significant historic properties related to traditional Hawaiian culture are located within the Village at Po‘ipū project area. Historic properties include both habitation and agricultural features, as well as possible human burials. Ongoing cultural practices within the project area include the gathering of native plants.

Section 3 Background Research

3.1 Traditional and Historical Background

3.1.1 Historical Setting: Pre-Contact Kōloa

The project area is located in the *ahupua‘a* of Kōloa in the Kona District on the island of Kaua‘i. Few records exist that document traditional Hawaiian life in Kōloa Ahupua‘a. While settlement by westerners with religious and commercial interests make the area a focus of documentation after the first quarter of the nineteenth century, the accounts generated generally focus on the lives and concerns of the westerners themselves, with only anecdotal references to the Hawaiian population. Two nineteenth century documents (Boundary Commission Testimony of 1874 and a Lahainaluna manuscript of 1885), however, did provide two Hawaiians an opportunity to speak for themselves and thus offer possible insight into the life of Kōloa before the arrival of westerners.

A dispute over the northern boundary of Kōloa Ahupua‘a in 1874 led to a hearing before Duncan McBryde, the Commissioner of Boundaries for Kaua‘i. One native witness, Nao (who describes himself as born in Kōloa but presently living in Ha‘ikū), in order to show that Hoaea (the area in dispute) was indeed at the northern boundary of Kōloa, testifies: “At Hoaea tea [sic] leaves were hung up to show that there were battles going on” (Boundary Commission, Kaua‘i, vol. 1, 1874:124). That there was a traditional “warning system” --well-known to all natives-- suggests that Kōloa, throughout its history, may well have been the scene of some serious conflicts--serious enough and perhaps often enough to warrant devising such a system.

Additional evidence of a rich history within Kōloa is offered in a Lahainaluna document produced eleven years later. This document appears to be based on an oral historical project. On September 7, 1885 a student from Lahainaluna Schools (HMS 43 #17) interviewed Makea – “a native who is well acquainted with Kōloa” -- and recorded “what she said about the well-known places in the olden times.” More than sixty-four years after the abolition of the *kapu* system and almost as many years of contact with westerners, Makea was able to describe in detail fourteen *heiau* within the Kōloa area; for example:

> Maulili was the first *heiau* of south Kōloa. Kapulauki was the first chief of Kōloa, Kiha came next. That is the chief I know of. He was a ruling chief of Kaua‘i in the olden days, when the *heiau* was standing there. It had already been built and men had been sacrificed on its altars. This Kiha was called Kiha-of-the-luxuriant-hair. Another name for him was Kakae and another was Ka-pueo-maka-walu (Right-eyed-owl).
>
> This *heiau* was also famous for this reason -- it was the first *heiau* to which Kawelo was carried after he had swooned in Wahiawa, in the battle where stones were used as missiles.
>
> The location of this *heiau* was not known, but a deaf mute knew and it was he who pointed it out to the chiefs, and that is how it was rediscovered in the olden days.

> Kiha lived on the eastern side of the *heiau* and Aikanaka lived on the northeastern side. This chief, Aikanaka, was the one with whom Kawelo fought and he was the owner of this *heiau* at that time.

3.1.2 Mythological and Traditional Accounts

Clearly Kōloa was a particularly important *ahupuaʻa* in traditional Hawaiian times. That at least fourteen *heiau* – of varying sizes and functions – have been documented in the Kōloa area (Thrum 1907, Bennett 1931) and the association of legendary-historic figures such as Kawelo and Aikanaka with the *heiau*, suggests a heightened cultural richness of the *ahupuaʻa*.

Further confirmation of a rich traditional life within Kōloa is furnished by the presence of a *hōlua* slide on the slopes of Puʻu o Hewa in the *mauka* reaches of the *ahupuaʻa* and by the myriad of legends attached to Maulili Pool, a sacred place once located in the present Kōloa Town. J. K. Farley (1907) describes the pool and its legendary associations:

> The pool of Maulili, on Waikomo stream...is a few hundred feet south of the Maulili road bridge. The gods Kāne, and his brother, Kanaloa, are said to have once slept above it, on its eastern bank and left the impress of their forms as can be seen in the *apapa*...The *apapa* in this vicinity is called an ‘*Unu*’ and a ‘*Heiau*,’ but was never walled in, it is said. [This *heiau* may be the Maulili Heiau described by Makea above.] On the nights of Kāne the drums are heard to beat there, also at the sacred rocks, or *unu's*, of Opuokahaku and Kānemilohae, near the beach of Poʻipū...
>
> In the Maulili pool lived a large *Moʻo*, named 'Kihawahine'...The eastern wall of the pool, just below the resting places of Kāne and Kanaloa, for a short distance, only, is called the ‘Pali of Kōloa’ The District of Kōloa is named for this *Pali*, we are told by old Hawaiians. To the south of the Pali o Kōloa, in the wall is a rock named ‘Waihanau’...as one of their *meles* has it:
>
> > *"Aloha wale ka Pali o Kōloa,*
> > *Ke Ala huli i Waihānau e, hānau."*
>
> To the south of Waihānau is a projecting rock named ‘Ke elelo o ka Hawaiʻi’ -- the tongue of Hawaiʻi, said to have been wrested and brought from Hawaiʻi by the Kauaʻi warrior Kawelo, of Wailua.
>
> At the southern end of the Maulili pool started two large *ʻauwai's*, that watered the land east and west of Kōloa (Farley 1907:93).

Thus, this sacred legend-imbued locus was the source that gave life to the lowland taro patches of Kōloa. These special associations would not have been lost on the Hawaiians dependent upon those waters.

While taro would have been essential to the life of the *ahupuaʻa*, other resources were available. Bernice Judd, writing in 1935, summarizes most of what was known -- into the first decades of this century -- of the traditional Hawaiian life of Kōloa:

> In the old days two large *ʻauwai* or ditches left the southern end of the Maulili pool to supply the taro patches to the east and west. On the *kuaunas* or

> embankments the natives grew bananas and sugar cane for convenience in irrigating. Along the coast they had fish ponds and salt pans, ruins of which are still to be seen. Their dry land farming was done on the *kula*, where they raised sweet potatoes, of which both the tubers and the leaves were good to eat. The Hawaiians planted *pia* (arrowroot) as well as *wauke* (mulberry) in patches in the hills wherever they would grow naturally with but little cultivation. In the uplands they also gathered the leaves of the *hala* for mats and the nuts of the *kukui* for light (Judd 1935:53).

It appears that the relatively good situation for the development of irrigated agriculture focused farming and habitation at elevations including the current project area (see Section 4: "The Kōloa Field System" below).

3.1.3 Early Historic Period

Accounts by visitors and settlers at Kōloa Ahupuaʻa focus on these westerners' own concerns--religious and commercial--as these concerns appropriate the historical record of Kōloa in the 1800s. However, scattered throughout the accounts are occasional references to the Hawaiians of the *ahupuaʻa*, which may give some insights into their lives.

The American Board of Commissioners for Foreign Missions (ABCFM) missionary Samuel Whitney described, in an article in the *Missionary Herald* (June 1827:12), a visit to Kōloa with Kaikioʻewa, the governor of Kauaʻi, in 1826:

> The people of this place were collected in front of the house where the old chief lodged in order to hear his instructions. After a ceremony of shaking hands with men, women, and children they retired...
>
> Our company consisted of more than a hundred persons of all ranks. The wife of the chief, with her train of female attendants, went before. The governor, seated on a large white mule with a Spaniard to lead him, and myself by his side, followed next. A large company of aipupu, *[ʻāʻīpuʻupuʻu*] cooks, attendants came on in the rear (p. 284).

Whitney's account suggests something of the deference paid to the *aliʻi* by the local populations and the scale at which the *aliʻi* carried out their functions. An even grander view of that deference is provided in an account of a later visit by an *aliʻi* to Kōloa. John Townsend, a naturalist staying in Kōloa in 1834, described a visit by Kamehameha III:

> In the afternoon, the natives from all parts of the island began to flock to the king's temporary residence. The petty chiefs, and head men of the villages, were mounted upon all sorts of horses from the high-headed and high-mettled California steed, to the shaggy and diminutive poney [sic] raised on their natives hills; men, women, and children were running on foot, laden with pigs, calabashes of Poe [sic], and every production of the soil; and though last certainly not least, in the evening there came the troops of the island, with fife and drum, and 'tinkling cymbal' to form a body guard for his majesty, the king. Little houses were put up all around the vicinity, and thatched in an incredibly short space of time, and when Mr. Nuttall, and myself visited the royal mansion, after nightfall, we found the whole neighborhood metamorphosed; a beautiful little village had

> sprung up as by magic, and the retired studio of the naturalists had been transformed into a royal banquet hall... (in Palama and Stauder 1973:18)

On December 31, 1834, Peter Gulick and his family arrived in Kōloa. Apparently the first foreigners to settle in the *ahupua‘a*, they initiated the process of rapid change that would re-shape the life of Kōloa in the nineteenth century. In 1835, a 30 by 60 ft. grass house was erected as a meeting house and school (probably located at Kōloa Town). Mr. Gulick initiated sugar cane cultivation and collected a cattle herd for the Protestant Mission. In 1837, a 45 by 90 ft. adobe church was built (probably at the same ABCFM site) and the first mission doctor, Thomas Lafon, arrived to assist Mr. Gulick (Damon 1931:179, 187). The Kōloa mission station apparently flourished immediately; Charles Wilkes, a member of the U.S. Exploring Expedition visiting Kōloa in 1840, recorded:

> The population in 1840, was one thousand three hundred and forty-eight. There is a church with one hundred and twenty-six members, but no schools. The teachers set apart for this service were employed by the chiefs, who frequently make use of them to keep their accounts, gather in their taxes &c [and for similar tasks]. The population is here again increasing partly by immigration, whence it was difficult to ascertain its ratio (Wilkes 1845:64).

Other sources, however, give different population figures for Kōloa during the first half of the nineteenth century. In 1834, according to a report by missionaries on Kaua‘i, the inhabitants of the *ahupua‘a* numbered 2,166. An article in the *Pacific Commercial Advertiser* of December 21, 1867 estimated that the population in 1838 was about 3,000 (though, by 1867, it had been reduced to a third of that number). James Jackson Jarves, who visited Kōloa and Kaua‘i for nine months during the early 1840’s, recorded:

> Kōloa is now a flourishing village. A number of neat cottages, prettily situated amid shrubbery have sprung up, within two years past. The population of the place, also, has been constantly increasing, by emigration from other parts of the island. It numbers, now, about two thousand people, including many foreigners, among whom are stationed a missionary preacher, and physician, with their families (Jarves 1844:100).

The arrival of “many foreigners” was the cause of, and the native immigration to Kōloa was the result of, the many commercial activities that burgeoned beginning in the 1830s. In 1835, Ladd and Company gained from the king and local chiefs the lease of about one thousand acres at Kōloa for 50 years at $300 a year and “allowed the use of the waterfall and an adjoining mill site at Maulili pool, not far from the thousand acres, together with the right to build roads, the privilege of unrestricted buying and selling and freedom from local harbor dues” (Judd 1935:57). Ladd and Company was not the first to mill sugar cane in the area: there was a Chinese-operated granite roller mill in operation at Māhā‘ulepū, Kōloa, in 1830; it was, however, the first plantation-organized industry in Hawai‘i (Damon 1931:176, 198). Judd notes the following:

> The company was permitted to hire natives to work on the plantation provided they paid Kauikeaouli, the king, and Kaikio‘ewa, the governor of Kaua‘i, a tax for each man employed and paid the men satisfactory wages. The workers were to be exempt from all taxation except the tax paid by their employers (Judd 1935:57).

Judd further described the revolutionary implication of this arrangement: “The significance of Ladd & Co.’s lease lay in the fact that it was the first public admission by the Hawaiian chiefs that their subjects had rights of personal property backed with a guaranty of protection to that property” (Judd 1935:58). Local chiefs, fearful of an usurpation of their power, resisted the company’s first efforts to recruit workers, forcing the king’s intervention.

The commercial activity initiated by the Ladd and Company plantation had widespread ramifications. Kōloa Town and the landing at the mouth of Waikomo Stream became major commercial centers. The landing – or “roadstead” as it was called – was a busy port during the mid-1800s. “An estimate in 1857 stated that 10,000 barrels of sweet potatoes were grown each year at Kōloa, and that the crop furnished nearly all the potatoes sent to California from Hawai`i. Sugar and molasses were also chief articles of export” (Judd 1935: 326). Whalers also used the Kōloa roadstead during this period (1830-1870) and took on provisions of squashes, salt, salt beef, pigs, and cattle. Hawaiians grew the squashes (pumpkins) on the rocky lands north of the landing, and numerous salt pans were located along the shore near the landing.

Ladd and Company ceased operating in 1845. Then, following a succession of individual and partnered ownerships, a new enterprise, Kōloa Sugar Company, was established in 1880. In 1948, the Kōloa Sugar Company became part of Grove Farm Company.

Another missionary, Dr. James W. Smith, who was stationed at Kōloa for forty-five years, beginning in 1842, mentioned in his journal a visit to “the school at Kukuiʻula.” If there was a second school in Kōloa outside the population center of Kōloa Town, Kukuiʻula may have warranted the placing of a school there because of a sufficiently large population in the area.

3.1.4 Mid-1800s (Land Commission Awards)

Toward the mid-19th century, the Organic Acts of 1845 and 1846 initiated the process of the Māhele – the division of Hawaiian lands – which introduced private property into Hawaiian society. In 1848 the crown, the Hawaiian government, and the *aliʻi* (royalty) received their land titles. Subsequently in the Mahele, Land Commission Awards (LCAs) were given to commoners and others who could prove residency on and use of the parcels they claimed.

The Māhele records of Kōloa give a picture of what had evolved by the middle of the nineteenth century when Kōloa Ahupuaʻa, totaling 8,620 acres, was awarded to Moses Kekūāiwa (LCA 7714-B), the brother of Alexander Liholiho (Kamehameha IV), Lot Kapuāiwa (Kamehameha V), and Victoria Kamāmalu. The awarding of the *ahupuaʻa* to Kekūāiwa was an outcome of an event twenty-five years in the past: the crushing - by forces loyal to Kamehameha II - of the 1824 revolt on Kauaʻi, when Kauaʻi lands were divided up among the chiefs of the other islands. The next largest award in the *ahupuaʻa* went to the Protestant Mission (ABCFM) (LCA 387) and consisted of approximately 825 acres. The majority of the mission lands were located in the vicinity of Kōloa Town, where the parsonage was located. Large parcels just *mauka* of Kōloa Town were utilized for sugarcane cultivation and cattle pasture.

Eighty-eight other *kuleana* awards were given to individuals within Kōloa Ahupuaʻa. The majority of these Land Commission Awards (LCAs) were located in or around Kōloa Town itself. This concentration of awards around the town area may reflect both the traditional land settlement pattern, a focus on the resources of Maulili Pool and Waikomo Stream (a permanent stream), and a more recent movement of the populace to the plantation and missionary centers.

An 1891 map of Koloa by M.D. Monsarrat shows the location of LCA parcels in the vicinity of Koloa Town (Figure 3). No LCAs were located within the current project area, though three LCAs (i.e. LCAs 3619, 3584, and 2668) were adjacent to the southern and western boundaries of the project area. Information on the awards from Mahele documents is presented in Table 1.

The Mahele documents indicate that, in the vicinity of the current project area, land usage and activity by the mid-nineteenth century included habitation and taro cultivation. This may reflect the continuation into that century of traditional Hawaiian land use within the project area.

Testimonies provided to the Land Commission by applicants give specific indications of land use, property boundaries, and land tenure. The following testimony in LCA 2668 was given by R.A. Walsh of the Roman Catholic Mission. Rev. Walsh stated:

> ...the spot where I now reside was given to me by Kahelemakule, the inspector of schools, by order he said of Kekauonohi [Governess of Kaua‘i Island].
>
> A part of the land was at that time occupied by a native named Kanehekili, and Kahelemakule said I might have his land in case Kanehekili agreed to it; who on my speaking to him, willingly resigned his part of the land gave me up all the title he had to it. Since this I have been left in the undisturbed possession of it. I have paid from 1 to 3 dollars each year for the land since, though I did not consider it was his majesty’s intention to impose any tax on me for it.
>
> The spot of land is in East Koloa, east of all the taro lands except mine and one other taro plot. It is bounded west, north and east by a water run, and on the south by an almost barren stoney place. In addition to the land contained in these boundaries, Kahelemakule allowed me to take a small spot on the north side of it whereon to build a chapel and schoolhouse.
>
> The land contains about 3 acres and only produces taro, sweet potatoes and grass. It has very little soil over a stratum of lava, and in many parts none at all.
>
> If not too intrusive on his Majesty’s liberality, I wish to extend the land a little to the north, that in the event of the plain being ceded to others, I might have grass for a horse and two or three cows. The place in unoccupied at present, and useless for any other purpose but grazing, and not good for that in dry weather, being covered with lava and with very little soil. I would fence in any portion of it that his majesty or the Gov[ernor] may grant me with a stone wall, to prevent any risk of trespass on my part. (Foreign Register Vol. 3:155-157)

Rev. Walsh identifies his parcel as located “east of all the taro lands except mine and one other taro plot,” suggesting that this portion of Kōloa comprises the eastern extent of the *lo‘i* (irrigated terrace) system of the *ahupua‘a* (i.e. the Koloa Field System). The *lo‘i* in this portion of Kōloa are fed by the “water run” that defines the western boundary of the Catholic Mission parcel. Rev. Walsh records that the parcel “only produces taro, sweet potatoes and grass,” which may summarize the products of other *kuleana* parcels in the vicinity. Similarly, the testimony to “very little soil over a stratum of lava, and in many parts none at all” likely describes overall conditions across the landscape, including within the current project area. Rev. Walsh also indicated that he would “fence in any portion [of his property]…with a stone wall,” as is indicated on the 1891 Monsarrat map (Figure 3).

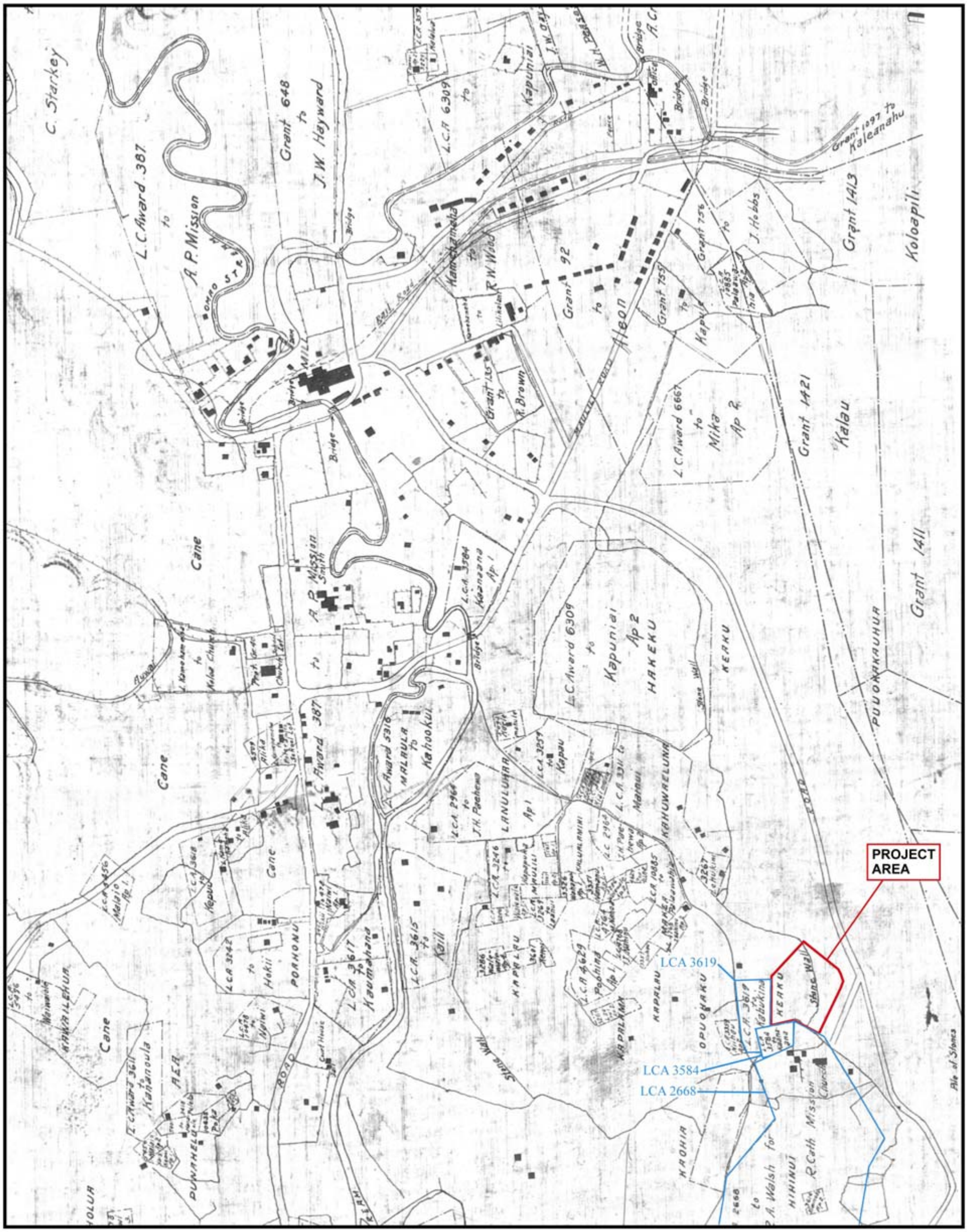

Figure 3. Portion of 1891 Map of Kōloa by M.D. Monsarrat (R.M.1694), showing the location of the project area and Land Commission Awards in the vicinity.

Table 1. Land Commission Awards Adjacent to the Project Area

LCA	Awardee	`Ili	Land Use
2668	Roman Catholic Mission (Robert A. Walsh)	Koloa Hikina	1 *lo‘i*, *kula*
3584	Kaanaana	Keaku	1 *lo‘i*
3619	Kahukina	Keaku	8 *lo‘i*, *kula*

Additional informative testimonies are provided in LCAs 3564 and 3619. These LCAs were awarded to native Hawaiians and testimonies were generally limited to stating the boundaries of their claimed lands as well as land use. Of particular interest are the stated boundaries of LCAs 3584 and 3619. The boundaries of LCA 3584 are described as “Mauka by Kahukina’s lo‘i” (i.e. LCA 3619) and “Puna (east) by Catholic Meeting house yard” (Foreign Testimony Vol. 13:3). The boundaries of LCA 3619 are described as “Puna [east] by the kula of Weliweli” and “Makai by Kaanaana’s Paahao lo‘i and the Catholic Church yard” (Foreign Testimony Vol 13:22). From this testimony, it appears that Kahukina (LCA 3619) claimed land which extended east to the area *mauka* of the Catholic Church yard, which was also to the east of Kaanaana’s lands (LCA 3584). Using the 1891 Monsarrat map (see Figure 3) as reference, this would indicate that Kaanaana’s claim included lands within the current project area, though it was not included in the awarded lands of LCA 3619. The awarding of lands smaller than those originally claimed was likely a common occurrence during the Māhele. The lands within the current project area were likely Kaanaana’s outlying kula land, used for dryland agriculture or as pasture. The 1891 Monsarrat map (see Figure 3) also indicates a “Stone Wall” running roughly north-south through the center of the current project area. To be included on the map, the wall must have been of significant size and function. This wall was likely a cattle barrier and may have been the eastern boundary of the lands claimed by Kaanaana and described as the boundary of “the kula of Weliweli.”

3.1.5 Late-1800s to Mid-1900s

Further documentation of the project area during the second half of the nineteenth century is found on a hand-drawn map by a *kama‘āina* Kōloa resident. Judge Henry Kawahinehelelani Blake of Kōloa (1874-1948) drew a colored map of “Koloa Village” depicting what the area looked like in 1888 when he was a boy of fourteen (Figure 4). The map suggests that widspread taro *lo‘i* continued to be in existence in the 1880s. The population of Kōloa, based on the house sites, continued to be dispersed across the Kōloa plain.

The current project area appears in the right-center portion of the map, *mauka* of the “Catholic Mission.” Judge Blake indicates several taro *lo‘i* and houses in the area *mauka* of the “Catholic Mission.” These *lo‘i* and houses likely represent the continuation, into the last decades of the nineteenth century, of the fields and house lots identified in the LCA records.

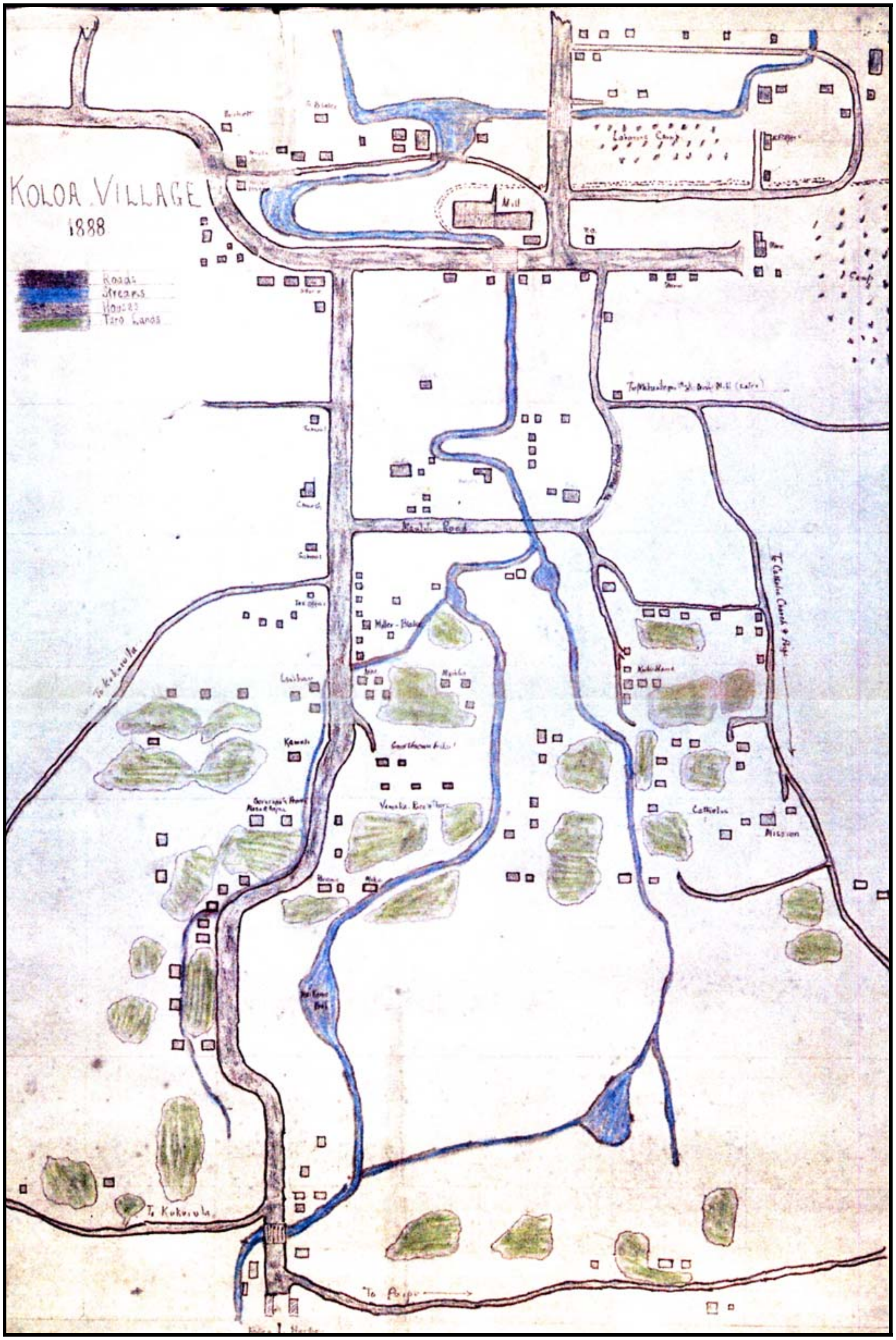

Figure 4. Hand-drawn map of Kōloa Village, 1888, by Judge Henry K. Blake (1874-1948) (Kauaʻi Historical Society).

Kōloa later became the scene of the confrontation of the traditional social structure with commercially-impelled forces of change. The cane growing activity of Ladd and Company would inevitably affect the lives of the inhabitants of the rest of the *ahupua‘a*. Traditional settlement patterns (e.g. permanent and temporary habitation interspersed throughout the irrigated agricultural fields near the coastal zone and traditional farming along streams) would have been distorted by a shift to settlement in Kōloa Town where sugar cane milling activities were located, and a shift to cash crops rather than taro.

The early success of Ladd and Company (before its bankruptcy in 1845) was an impetus for other entrepreneurial attempts within Kōloa. Silkworm farming, oil extraction from *kukui* nuts, cigar manufacturing, sago raising, and tapioca manufacturing were all attempted with varied success during the middle third of the nineteenth century.

Another major area of commercial enterprise was associated with the whaling industry at Kōloa Landing. Accounts of visitors suggest that the inhabitants of Kōloa took advantage of their nearness to the landing to participate in the booming trade of the port. An article in the *Pacific Commercial Advertiser* of Feb. 19, 1857 described the salient characteristics of the port at mid-century and mentions:

> From the landing there is a good carriage road to the town, distant about two miles. Large quantities of firewood, bullocks and sweet potatoes are furnished to whalers in this port, and these chattels can nowhere be procured cheaper or better. It is estimated that 10,000 barrels of sweet potatoes are cultivated annually here, which are thought to be the best on the islands. Nearly all the potatoes furnished for the California market are produced here...Sweet potatoes, sugar and molasses constitute the chief trade of the port.

Kōloa became the official port of entry for Kaua‘i in the 1850s and participated in the profitable trade with the whaling industry whose peak years ran from the 1830s to the 1860s. It seems likely the demand for firewood, bullocks, sweet potatoes, sugar and molasses at Kōloa Landing was met to at least some small degree by activities in the *mauka* regions of Kōloa.

During the later decades of the nineteenth century the Knudsen family would enter into the Kōloa historical record. As Donald Donohugh (2001:191) notes:

> Valdemar Knudsen came to Kaua‘i from Norway by way of California in 1852, built a home in Kekaha, which he named ‘Wai‘awa’ (bitter water), and started a cattle ranch there. In 1865 he married Anne Sinclair, daughter of Eliza Sinclair, who owned the island of Ni‘ihau and the *ahupua‘a* of Makaweli (fearful features). Eliza bought most of the Kōloa *ahupua‘a* in 1870 and gave it to Anne that year as a dowry. When Valdemar died, Anne set up a trust and through it leased her land first to Kōloa Plantation, then to Grove Farm, and finally to McBryde. Anne died in 1920, and Knudsen descendants formed trusts in their own names. First Hawaiian
>
> Bank manages the activities of all of them. Rather than speaking of several trusts, it is customary to use the generic term Knudsen Trust, as we will here.

The current project area is a portion of the Eric A. Knudsen Trust.

Sugarcane cultivation in Kōloa expanded in the 1890s with the forming of McBryde Sugar Company. Benjamin F. Dillingham incorporated “three estates, namely Kōloa Agricultural Co. (no connection with Kōloa Sugar Co.), ‘Ele‘ele Plantation, and Wahiawa Ranch” (Conde and Best 1973:191). Theo H. Davies was the acting agent until 1901 when Alexander and Baldwin took over agency control.

Expansion of cane fields and plantation rail lines was rapid. By 1903, McBryde had completed rail lines to its Kōloa fields and Kōloa Landing. The manager’s report of 1904 notes: “Our permanent railroad had been graded into Kōloa Village...A span has also been run down from the main track to the coral sand beach between Kukuiula and Kōloa landing, so that we are able to load sand as required from fertilizer and other uses...” (Conde and Best 1973:191). By the first decades of the twentieth century, cane fields of the Kōloa Sugar Company and McBryde Sugar Company spanned the landscape of Kōloa. However, sugar company field maps from the early 1900s do not indicate sugarcane was cultivated within the current project area.

Kōloa Landing was phased out around 1925 when McBryde Sugar Company and Kōloa Sugar Company began using Port Allen. Soon after, McBryde ceased to use several of the Kōloa fields.

A second map drawn by Judge Henry Kawahinehelelani Blake shows “Kōloa Village” in 1938 (Figure 5). The map was likely drawn by Judge Blake in 1938 along with the map of the village in 1888 to record a “then and now” portrait of Kōloa. The map indicates “cane lands” and “pasture” in the vicinity of Kōloa Town. The taro *lo‘i* that characterized the Kōloa landscape in the 1880s are no longer present.

3.1.6 Modern Land Use

A 1951 aerial photograph of Kōloa (Figure 6) indicates the eastern portion of the project area consisted of low grass pasture for grazing livestock. The western portion of the project area appears to be more heavily vegetated, and likely consisted of lands unsuitable for pasture. No structures appear to be located within the project area.

3.2 Previous Archaeological Research

3.2.1 Overview of Archaeological Studies within Kōloa Ahupua‘a

Thomas Thrum was the first to discuss sites in the Kōloa area in his list of the *heiau* of Kaua‘i (Thrum 1907). He discussed six *heiau* in the district of Kōloa, which once extended from Hanapēpē to Māhā‘ulepū. The *heiau* were Hanakalauae, Kanehaule (inland Kōloa Ahupua‘a), Kihouna (Kōloa Ahupua‘a), Kaneiolouma (Kōloa Ahupua‘a), Weliweli (Weliweli Ahupua‘a), and Waiopili (Māhā‘ulepū Ahupua‘a). The two *heiau* on the Kōloa coast, Kaneiolouma and Kihouna, were described as: “Near the Po‘ipū beach, at Kōloa, are two walled *heiaus* but a short distance apart.” (Thrum 1907:36-37:68)

The earliest systematic archaeological survey on the Island of Kaua‘i was conducted by Wendell Bennett in the late 1920s. Bennett examined and recorded 202 sites on the island. According to his site location map (Figure 7; Bennett 1931:98), Sites 74 to 81, 85-86, and 91-92 are within or in the vicinity of Kōloa Ahupua‘a.

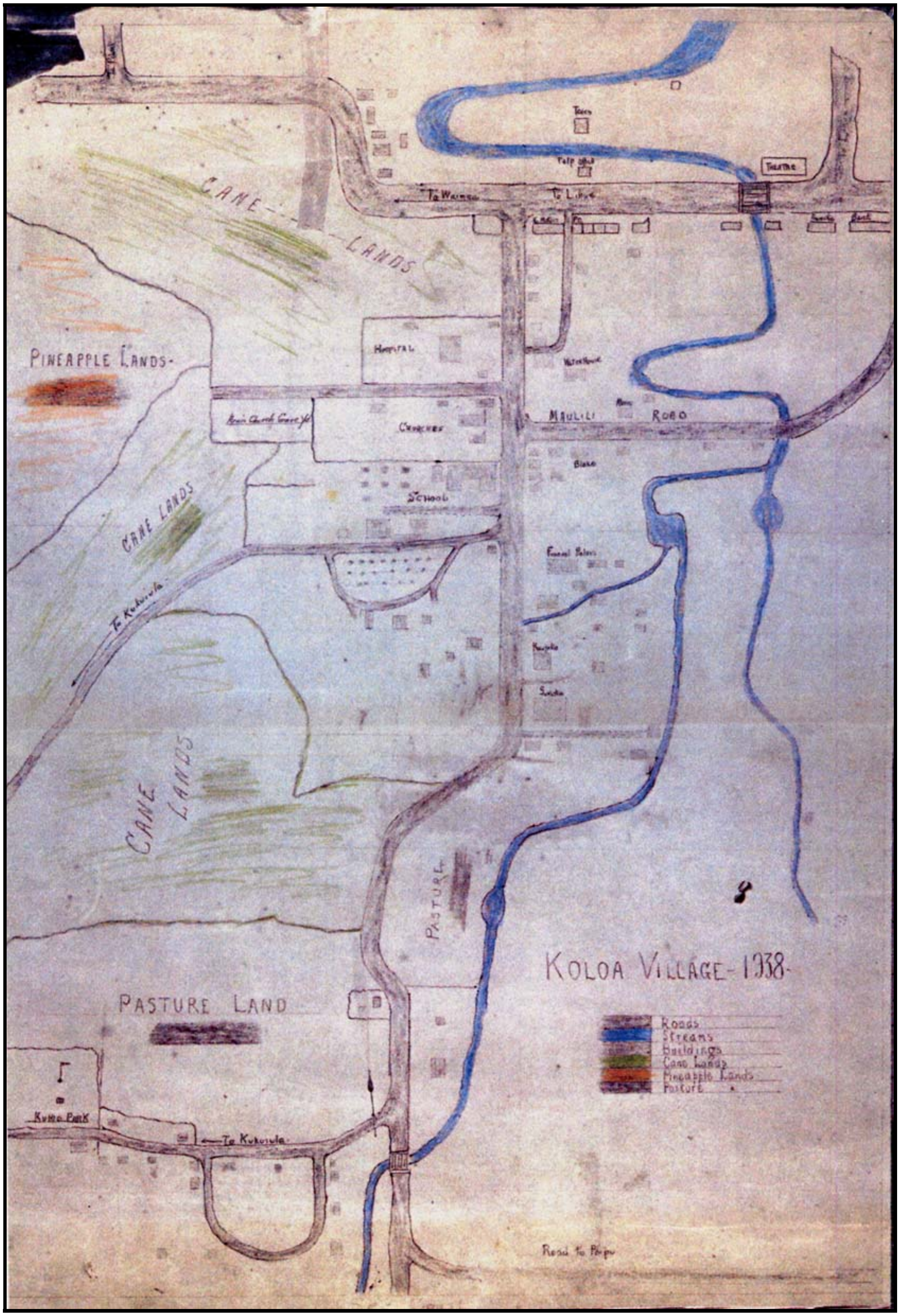

Figure 5. Hand-drawn map of Kōloa Village, 1938, by Judge Henry K. Blake (1874-1948) (Kaua‘i Historical Society)

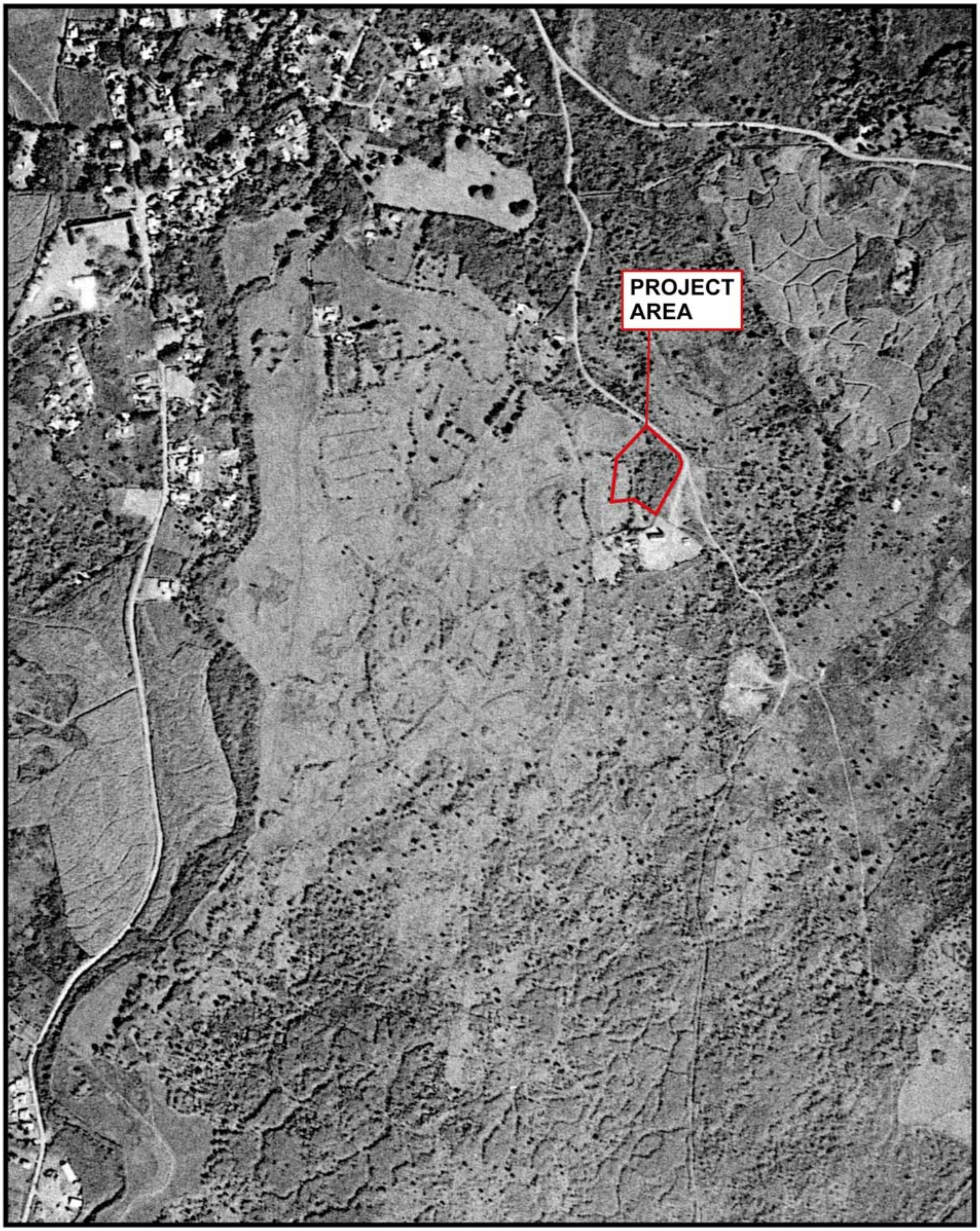

Figure 6. Aerial photograph of Kōloa (1951) with current project area indicated.

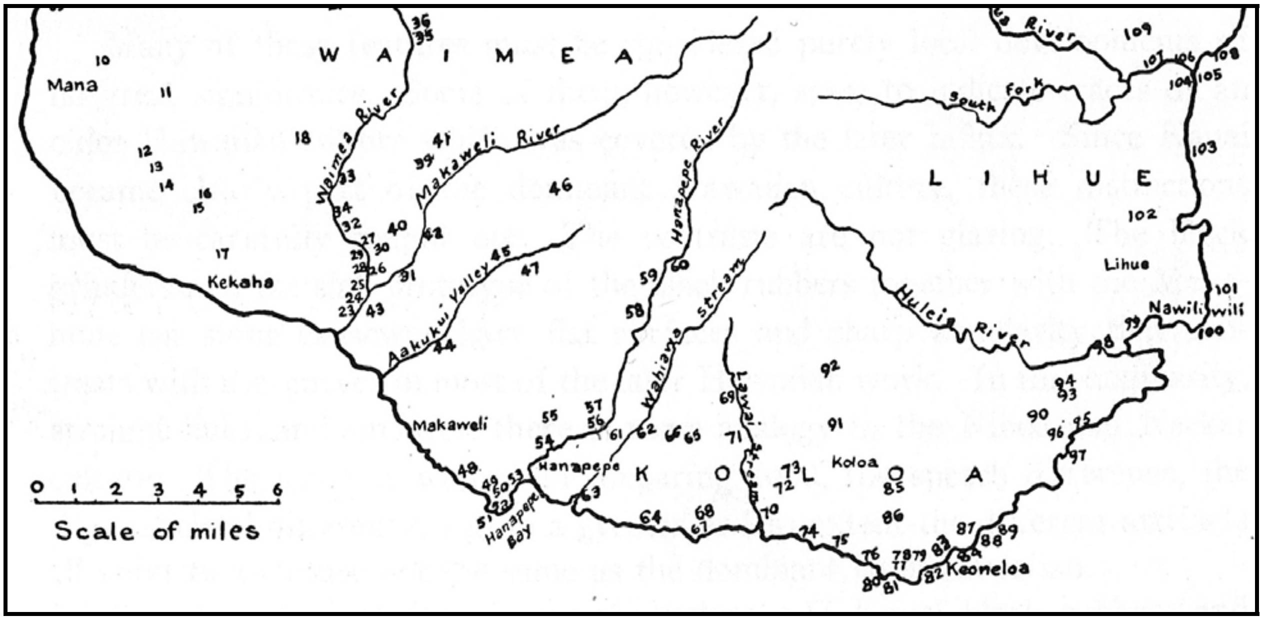

Figure 7. Portion of Bennett (1931) Index map of Kaua‘i, showing archaeological sites in the Kōloa vicinity.

Selected Archaeological Sites Located by Bennett (1931) in Koloa Ahupua‘a

Site 74. Fishing shelter. On the shore near the mouth of Kukuiula valley there is a fishing shelter.

Site 75. Kuhio Park, on the shore west of Waikomo stream, Koloa. Taro patches, a small heiau, an oven, paved house platform, fish pond, game ground with seats around, and a fishing shrine are the principal features shown.

Site 76. Salt pans, east of Waikomo stream along the shore.

Site 77. Ponds, just inland from the shore road at the east side of the Weliweli, Koloa.

Site 78. Taro terraces and house sites, just east of Site 77 and adjoining it.

Site 79. Walled inclosure [*sic*] and house sites, just northeast of Site 78, Koloa.

Site 80. Kihouna heiau, at Kihouna point, Poipu, Koloa.

Site 81. Kaneiolouma heiau, on the shore a short distance east of Site 80.

Site 85. Walls, inclosures[sic], house sites, in the cactus-covered country around the Koloa reservoir and extending to the sea.

Site 86. House site, in the area described in Site 85.

Site 91. Holua slide, on the hill named Puu o Hewa just above Koloa off the main road.

Site 92. Kanehaule heiau, at Kaunuieie, Koloa.

Figure 8 illustrates areas of previous archaeological studies in the Kōloa Ahupua‘a. Table 2 contains a summary of previous archaeological studies within Kōloa Ahupua‘a.

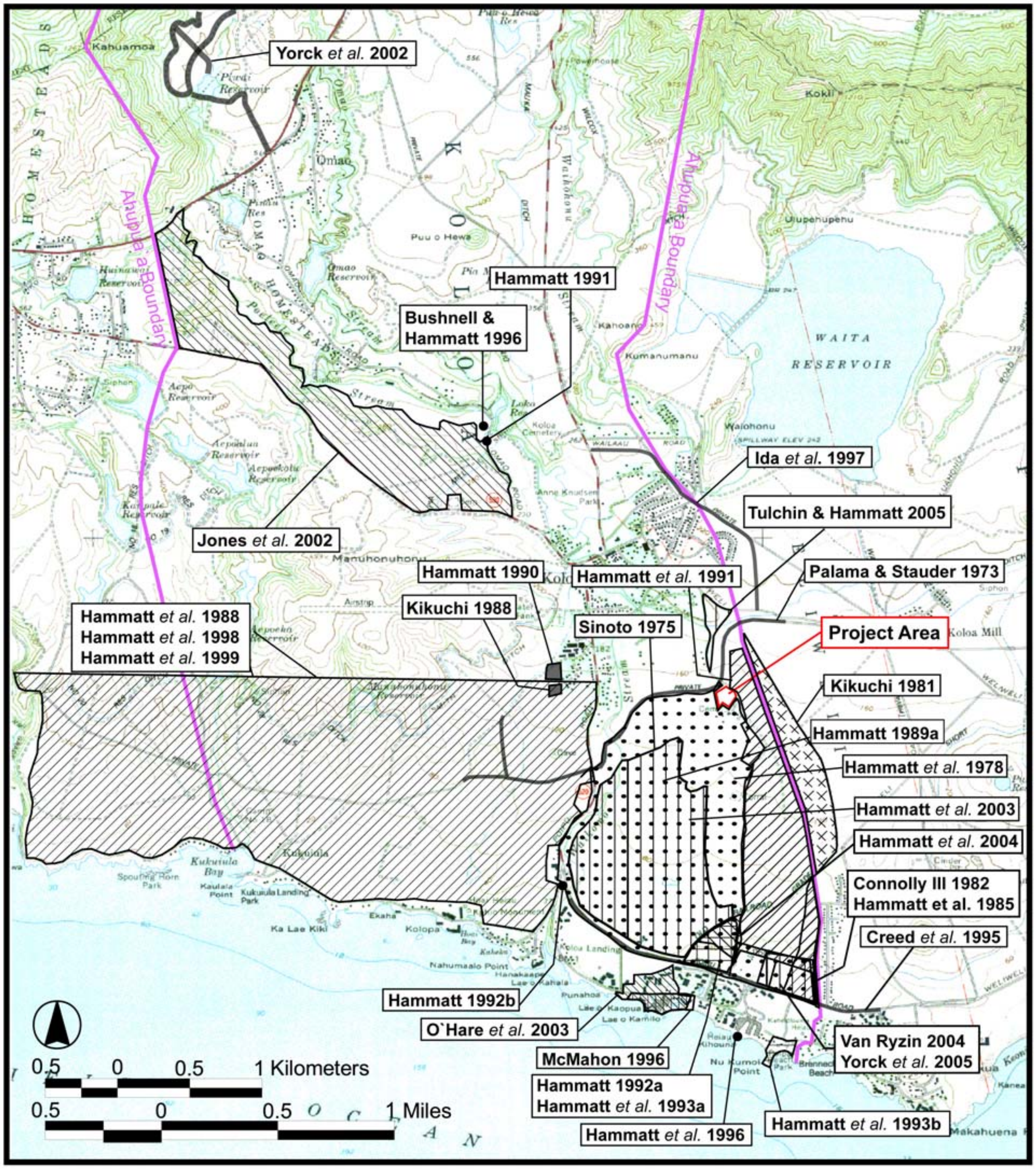

Figure 8. Previous archaeological studies within Kōloa Ahupuaʻa.

Table 2. Previous Archaeological Studies within Kōloa Ahupua‘a

AUTHOR	YEAR	LOCATION	STUDY TYPE
Bennett	1931	Kukui‘ula Valley, Prince Kūhiō Park	General Survey
Kikuchi	1963	Kona District	General Survey
Kikuchi	1973	Hawaiian Fishponds	General Survey
Palama and Stauder	1973	Cane Haul Road-Kōloa Mill	Reconnaissance Survey
Sinoto	1975	Knudsen Trust Lands	Reconnaissance Survey
Bordner	1977	Kukui’ula *‘auwai*, Site 50-39-10-1934	Reconnaissance Survey
Hammatt, et al.	1978	Kīahuna Complex	General Survey
Kikuchi	1979	Sheraton Kaua‘i Hotel	Survey and Subsurface Testing
Connolly	1982	Kōloa-Po‘ipū Bypass Road	Reconnaissance Survey
Ching	1983	Kukui‘ula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Landrum	1984	Kukui‘ula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Hammatt, et al.	1985	Kōloa-Po‘ipū Bypass Road	Survey and Subsurface Testing
Kikuchi	1985	Shoreline Improvements, Wai‘ohai Hotel, Kihouna Heiau	Reconstruction
Kikuchi	1988	Pa‘anau Sugar Camp	Reconnaissance Survey
Hammatt et al.	1988	Kukui‘ula Bay Planned Community	Inventory Survey
McMahon	1989	Kaua‘i Fishponds	General Survey
Hammatt	1990b	Pa‘anau Housing Project	Inventory Survey
Hammatt, et al.	1991	Po‘ipulani Golf Course	Inventory Survey
Hammatt	1991b	Pō‘ele‘ele Stream–Waterline crossing	Archaeological Reconnaissance

AUTHOR	YEAR	LOCATION	STUDY TYPE
Hammatt	1992a	Kīahuna	Inventory Survey
Hammatt	1992b	Po‘ipū Road and Lāwa‘i Road Junction	Archaeological Reconnaissance
Hammatt, et al.	1993a	Po‘ipū Road 7.6-acre Parcel	Inventory Survey
Hammatt et al.	1993b	Po‘ipū Beach Park	Subsurface Testing and Monitoring
Creed, et al.	1995	Po‘ipū Road	Inventory Survey
Bushnell and Hammatt	1996	‘Ōmao Bridge, ‘Ōmao Homestead	Archaeological Investigation
Hammatt, et al.	1996	Wai‘ohai Resort	Assessment Survey
McMahon	1996	Sheraton Kaua‘i Resort	Reconnaissance Survey
Ida, et al.	1997	Po’ipū Bypass Road	Inventory Survey
Hammatt, et al.	1998	Kukui’ula Planned Community Phase I	Data Recovery
Hammatt, et al.	1999	Kukui‘ula Planned Community Phase II	Data Recovery
Yorck, et al.	2002	Kaumuali‘i Highway, Alexander and Baldwin Properties	Inventory Survey
O’Hare, et al.	2003	Sheraton Kaua‘i Resort	Archaeological Assessment
Rohrer, et al.	2003	Kapili Road at Po‘ipū Road 10.6 acre parcel	Archaeological Assessment
Hammatt, et al.	2004	400 acre parcel at Kiahuna Golf Village and KMP Development Project Parcels	Inventory Survey and Data Recovery
Esh and Hammatt	2004	Railroad Berm proximate to Village at Po‘ipū Development, Kiahuna Golf Course.	Data Recovery Plan
Yorck and Hammatt	2005	Kapili, Po‘ipū and Ho‘onani Roads	Archaeological Monitoring
Dockall, et al.	2005	Po‘ipū Beach Park, Mauka Preserve	Inventory Survey

Bennett’s (1931) Sites 85 and 86 were located nearest to the current project area. Site 85 includes many features located “around the Koloa reservoir and extending to the sea,” which would have included the vicinity of the current project area. Site 86 consisted of a particularly well-constructed and complex house site within the Site 85 area. A detailed description of Site 85 is as follows:

> Site 85. Walls, inclosures, house sites, in the cactus-covered country around the Koloa reservoir and extending to the sea.
>
> Innumerable walls, some of them inclosures and some merely division walls and fences. In one large walled inclosure were three piles of stone near one end…There are some fine house sites on flat places on the lave flows, slightly leveled with small stones. House sites about 10 by 15 feet are found everywhere on the lava. The walls are of different types of construction and some have been restored for modern use; double rows of large stones on edge filled in with small stones; walls built up of same size stones; walls built of blocks of lava set upright. Some walls are 6 feet and others 2 feet high. (Bennett 1931:120)

William Kikuchi (1963) conducted a general survey of the Kona District of Kaua‘i including all *ahupua‘a* from Hanapēpē, eastward to Kīpū Kai. Information from Thrum (1907), Bennett (1931), a Lahainaluna School manuscript (1885), and other sources was instrumental in helping to locate major archaeological sites during the field survey. Kikuchi’s survey was selective, as it was not designed to be a complete inventory, and focused on generally larger or more coastal sites.

William Kikuchi (1973) completed his dissertation on Hawaiian Aquacultural Systems in 1973. Within this study, he listed all known fishponds and classified them into six types. A “nameless pond” at Lae o Kamilo, Kōloa was classified as a Type II pond, 0.10+ acres, with a *ko‘a* shrine (fisherman’s shrine) within the pond. A Type II pond was called a *loku pu‘uone* and is described as “an isolated shore fishpond usually formed by the development of barrier beaches building a single, elongated sand ridge parallel to the coast and containing one or more ditches and sluice gates” (*ibid*:228). In a survey of Kaua‘i fishponds completed in 1989 by Nancy McMahon, a pond on the Kōloa coast was classified as a Type II(b), which is a *loko pu‘one* pond that was entirely excavated by man. McMahon describes this pond as “seen along Poipu shoreline, development has changed area, oval in shape, 185 yards in circumference, bank on *pahoehoe*” (McMahon 1989). According to Bennett (1931) and Kikuchi (1963), there were several “salt pans” or brackish water pans along the Po‘ipū coast. Bennett’s Site 77, which is located more towards the east, adjacent to the *ahupua‘a* of Weliweli, is described as a series of ponds, with one pond 185 yards in circumference (Bennett 1931). Thus, McMahon may be describing a different pond than Kikuchi.

Stephen Palama and Catherine Stauder (1973) conducted a reconnaissance survey along the route of the then-proposed main cane haul road to the Kōloa mill site. The proposed new section of road extended from Weliweli Road, southwestward across Po‘ipū Road, connecting to an existing cane haul road. This road corridor crossed a portion of Weliweli Ahupua‘a and both east and west Kōloa at a distance of between two-thirds to two miles from the coast. A total of 18 sites were recorded along the road corridor. Although the Palama and Stauder study was limited in scope to the proposed road right-of-way, it included a short but thorough historical summary of the locations of archaeological sites within the context of the Kōloa Ahupuaʻa and Weliweli Ahupuaʻa. An extensive *ʻauwai* system was observed east of Poʻipū Road. The following comments on this system and the sites in general are relevant to understanding the archaeological significance of the area as a whole, and the historic processes at work:

> Our reconnaissance revealed that the most significant archaeological feature located within the study area is the extensive *ʻauwai* system. Remnants of this irrigation system were observed on both sides of the Waikomo Stream...[This] network of watering canals proved to be the key to the success of the prehistoric Hawaiian Culture in turning these marginal lands into flourishing wet and dry agricultural fields. From information gathered from local informants and preliminary historical investigation of this area it is evident that the early commercial growers of sugar cane utilized the existing *ʻauwai* system. Gradually as more and more fields came under sugar cane production these replaced the wet and dry fields of an earlier day. Today the archaeological sites remaining stand as islands as these marginal cane lands were taken out of production and turned into pasture (*ibid*:4).

Akihiko Sinoto (1975) conducted a reconnaissance survey of 400+ acres of Knudsen Trust Lands at Kōloa, in the area north of Poʻipū Road. He recorded several features and suggested they were the northern remnants of Bennett's Sites 78, 79, 85 and 86.

Richard Bordner (1977) conducted a one-day reconnaissance survey of a specific *ʻauwai* located in Kukuiʻula, which corresponded to the major *ʻauwai* system assigned SIHP Site 50-30-10-1934. The *ʻauwai* traversed Kukuiʻula from northeast to southwest and included a number of associated remnant fields. A portion of this *ʻauwai*, (which consisted of a raised "aqueduct" type section), was recommended for preservation (ibid. 1977:26).

Hallett Hammatt, Richard Bordner, and Myra Tomonari Tuggle (Hammatt *et al.* 1978) as part of Archaeological Research Center of Hawaii (ARCH), reported on a general survey of 460 acres for the then-proposed Kīahuna Golf Village, located on the east side of Waikomo Stream and Poʻipū Road. The Kīahuna survey recorded 583 archaeological sites including 175 stone enclosures and 108 stone house platforms, some of which appeared as clusters of family compounds. The water channels (*ʻauwai*), ponded fields, terraced plots, and mounded fields all indicated extensive wet and dry land agriculture (*ibid*:5). The water source for this highly integrated agricultural system, called the Kīahuna Complex, was Waikomo Stream, which was tapped upstream. Additional sites included 10 occupation caves and a *heiau*.

William Kikuchi (1979) conducted a reconnaissance survey of the *mauka* portion of the Sheraton Kauaʻi Resort, north of Poʻipū Beach Road, in 1979. This survey took place before the Sheraton Kauaʻi Resort expanded construction of their hotel to their northernmost parcel, although some sections had been significantly altered by bulldozers and paved for use as a parking lot. Kikuchi found agricultural features in the northeastern portion of the project area, and concluded that the area lay within the coastal fringe part of the agricultural and habitation zone that extended inland all the way to Kōloa town. A tidal pool, a railroad berm, and several stone walls were also recorded in the area.

Robert Connolly (1982) conducted a reconnaissance survey of sections (310 acres) in the *ahupuaʻa* of Kōloa and Weliweli in 1982 for the Kōloa-Poʻipū Bypass Road. The sites that

Connolly encountered were predominantly wall remnants, a few rock mounds, a hole, two complexes, a railway causeway, and an enclosure.

Francis Ching (1983) conducted a reconnaissance survey, and an historical investigation of 230+ acres of Alexander and Baldwin lands within the *ahupuaʻa* of Kōloa (west Kōloa) and Lāwaʻi. According to Ching, three-fourths of the study area was bulldozed, with many rocks re-located, however, remnants of walls, *loʻi* (wetland cultivation), ʻ*auwai* (irrigation ditch) flumes, terraces, and an historic railroad berm were still discernable. These remnants are evidence of the great expanse of the Kōloa Field System.

James Landrum (1984), of the Bishop Museum, conducted a reconnaissance survey of a 200+ acre portion of Kukuiʻula. Landrum recognized that his survey area was once part of an extensive irrigated agricultural complex developed in the prehistoric period with superimposed historic-era occupation (*ibid*:24).

Hallett Hammatt, Douglas Borthwick, and David Shideler (1985) conducted a survey with subsurface testing for the proposed Kōloa-Poʻipū Bypass Road, which extended 9,000 ft. along the boundary of Kōloa and Weliweli Ahupuaʻa. The road corridor was proposed to connect Poʻipū Road (the beach road) to Weliweli Road, southeast of Kōloa Town. A total of 47 archaeological features were located along the corridor. These were concentrated at the southern end of the corridor and included the southeastern portion of the "Kīahuna Complex" documented by Hammatt *et al.* in 1978.

Hallett Hammatt, Douglas Borthwick, David Shideler, and Mark Stride (Hammatt et al. 1988) conducted an archaeological inventory survey in the 1000-acre proposed Kukuiʻula Bay Planned Community. Fifty-eight archaeological sites were recorded; many associated with the Kōloa Field System. Two to three *heiau* were found, possibly including the remains of Kamaloula Heiau.

William Kikuchi (1988) conducted a reconnaissance level survey of the former Paʻanau Sugar Camp. The camp was located just south of the present day Kōloa Elementary School. The survey recorded a number of cement foundations, ditches, and portable historic artifacts. Kikuchi states that archaeologically, the site is interesting because it contains remnants of an early (1910-1950) plantation camp, even though the vast majority of its structures have been destroyed or removed.

Hallett Hammatt (1990) conducted an inventory survey of a 4.7-acre parcel at the west end of Paʻanau Road near Kōloa town. The historical segment of this report indicates the previous existence of the Paʻanau Camp, and a railway and ʻ*auwai* irrigation ditch which traversed the study area. However, the survey revealed the absence of any traces of pertinent features.

Hallett H. Hammatt (1991) carried out an archaeological reconnaissance for a proposed waterline stream crossing of Pōʻeleʻele Stream, north of Kōloa town. He noted extensive modern land modification and no significant findings.

Hallett H. Hammatt (1992a) carried out an archaeological inventory survey of a 3.8 acre property at Kīahuna, (TMK 2-8:014-026), but the entire parcel had been previously graded and there were no significant findings.

Hallett H. Hammatt (1992b) carried out an archaeological reconnaissance of the Poʻipū Road and Lāwaʻi Road Junction near the mouth of Waikomo Stream*,* but again there were no significant findings, owing to prior land disturbance.

Hallett H. Hammatt, Gerald Ida, and William Folk (Hammatt *et al*. 1993a) conducted an archaeological inventory survey, with limited subsurface testing, of 7.6 ac. (TMK 2-8-14:30) in east Kōloa. This parcel is north of Poʻipū Road and south of the former railroad grade. Site 3758, a house platform or possible *heiau*, was re-mapped, and three new sites habitation/agricultural complexes were recorded. According to Hammatt *et al.* (1993:21), these sites are remnants of traditional ʻ*auwai*, walls, fields, enclosures and habitation platforms, and appear to be a part of the larger Kōloa Field System, which encompassed over 1000 acres.

Hallett Hammatt, Gerald Ida, William Folk, David Shideler and Brian Collin (Hammatt *et al.* 1993b) conducted an assessment survey, subsurface testing and monitoring at Poʻipū Beach Park in the *ahupuaʻa* of Kōloa. Wave action during Hurricane ʻIniki in 1992 had exposed a cultural layer (Site 50-30-10-745) which needed to be preserved and monitored during the reconstruction and restoration of the park. Auger testing (*ibid*:11) revealed charcoal, and both traditional and historic midden and artifacts (*i.e.* basalt flakes and fragments, nails, glass, *kukui* shells, and mollusk shells). An historic cemetery (State Site 50-30-10-1871), located in the middle of Poʻipū Beach Park, and other sections of the buried cultural layer beneath the park, were also monitored during the removal of several cement slabs, remnants of a pavilion, picnic tables, and barbecues. Three radiocarbon dates were determined for this layer: the earliest was A.D. 1282-1414 and latest ranged from A.D. 1678-1940 (*ibid*:52). The rich cultural layer, supported by radiocarbon dating, indicates that this shoreline occupation is contemporaneous with the development of the Kōloa Field System. This cultural layer is the "single largest coastal beach deposit in the *ahupuaʻa*...of Kōloa" (Hammatt *et al.* 1993b:65, 66) and greatly contributes to the information bank regarding the cultural development of the Kōloa district.

Victoria Creed, Gerald Ida and Hallett H. Hammatt (1995) reported on an inventory survey within a 1.4-mile corridor along the *mauka* (inland) side of Poʻipū Road (TMK 2-8-15, 16, 17 & 18) in the *ahupuaʻa* of Kōloa and Weliweli. Three sites, including enclosures, a terrace, and the Kōloa-Weliweli boundary wall, survived previous bulldozing of the area and were understood as components of the Kōloa Field System.

Kristina Bushnell and Hallett H. Hammatt (1996) carried out an archaeological investigation of ʻŌmao Bridge in ʻŌmao Homestead but the only objects of historical interest noted were the existing bridge and features associated with an old railroad.

Hallett Hammatt, Victoria Creed, and Gerald Ida (1996) conducted an assessment survey of an exposed cultural layer in undisturbed sand deposits at the Marriott Waiʻohai Resort. This layer was disturbed by high wave action during Hurricane ʻIniki, which completely destroyed the associated reconstructed Kihouna Heiau (Site 50-30-10-80). Three charcoal samples from this layer were dated to A.D. 1430-1950. The exposed cultural layer supports the potential existence of widespread intact cultural areas along the general shoreline (Hammatt *et al.* 1996:36, 39).

Nancy McMahon (1996), completed a reconnaissance survey of TMK 2-08-16:3 (8.444 acres), a part of the Sheraton Kauaʻi Resort, to report on damage caused by Hurricane ʻIniki. The reconnaissance was performed *makai* of Poʻipū Beach Road. No surface sites or cultural deposits were reported. She noted a sandy deposit up to the foundations of the buildings on the eastern side the Resort near Lae o Kamilo. She suggested that the remnants of beach dunes could still exist and recommended monitoring of any construction in this area in case historic sites, including human burials, were uncovered.

Beginning in December of 1996, reconstruction of areas damaged by the hurricane began at the Sheraton Kaua‘i Resort. At that time, an intact cultural layer, designated Layer III was uncovered. Additional cultural material encountered during monitoring of construction activities included 8 human burials, 6 fire pits, a concentration of fire cracked rocks, a C-shaped structure, and a pig skeleton. Six charcoal samples were submitted for radiocarbon age determination for Layer III. These ranged from 20+/- 70 BP (before present) to 540+/- 60 BP, indicating that the earliest possible date for the features was A.D. 1400. It may have been constructed much later. All human skeletal remains were reburied at a location north of Po‘ipū Beach Road, marked by a plaque and a reconstruction of Feature H.

Gerald Ida, Victoria Creed and Hallett H. Hammatt (1997) conducted a reconnaissance survey on a 1.2 mile corridor of a proposed bypass road within the *ahupua‘a* of Kōloa and Weliweli (TMK 2-8-02:3, 2-8-03:1, 2-8-04:1, 2-8-05:2) that had previously been bulldozed. This road extended from an existing bypass road at the coast to north of Kōloa town. This survey did not reveal any archaeological sites, and further study was not recommended.

Cultural Surveys Hawai‘i, Inc. (Hammatt, *et al*, 1998) reported on data recovery of the Kukui‘ula Planned Community Project Phase 1 area encompassing approximately 219 acres (Hammatt *et al*. 1998). The project included excavations at 20 different sites, which encompassed 64 individual features. There were a total of 212 excavation units (212 square meters) and 19 backhoe trenches (only 14 backhoe trenches were chosen for study). Large quantities of midden (approx. 23.7 kilograms) and artifacts (10,635 items) were recovered and were reported on. The artifacts include a wide range of types with both indigenous (2,592 items) and historic (8,043 items) represented. Radiocarbon (C14) dates ranged from ca. A.D. 1050 onward. The earliest date came from the habitation/burial cave Site 50-30-10-1927A. In addition to the habitation sites and features dated, seven dating samples from agricultural features were also analyzed.

Cultural Surveys Hawai‘i, Inc., (Hammatt, *et al*, 1999) performed data recovery of a parcel southwest of Kōloa Town, on the west bank of the Waikomo Stream, in the northeastern portion of the Kukui‘ula Planned Community Phase II Area (Hammatt *et al.* 1999). The study area consisted of approximately 33 acres that had been used as a buffer zone between cane lands/pastures and residential lots bordering Po‘ipū Road. While some ten Land Commission Awards (LCA) lay partially or entirely within the project area, most of these properties were bulldozed in the course of sugar cane cultivation. There were areas that appeared undisturbed by sugar cane cultivation. Excavations were conducted within five archaeological sites consisting of 13 features. These excavations yielded 264.8 grams of midden; 53 indigenous artifacts (including 43 volcanic glass flakes, 9 basalt flakes, and one coral manuport); and 877 late-historic artifacts (*e.g.* glass, metal, ceramics, plastic, leather, and slate). Twelve charcoal samples were dated, and ranged from A.D. 1250-1410 to A.D. 1800

Jesse Yorck, David Shideler, and Hallett Hammatt (2002) conducted an inventory survey of three proposed well sites near Pīwai Reservoir north of ‘Ōmao Homesteads. No archaeological sites were identified in the project area or vicinity.

Hammatt et al., (2004) conducted an inventory survey of five project areas on approximately 400 acres of the Kīahuna Golf Village; wherein 509 historic properties were documented and 80 historic properties were excavated. The 509 historic properties included 238 permanent habitation sites, 150 temporary habitation sites, 2 habitation/agricultural sites, 104 agricultural sites, 2 artifact sites, 1 rock art site, 1 historic grave, 1 ceremonial site, and 10 miscellaneous sites used for either storage or livestock.

The Kīahuna Golf Village inventory survey included data recovery within 80 historic properties. 12,153.7 grams of midden were excavated, which included 1017 indigenous artifacts (607 lithic items, 174 bone items, 148 coral items, 45 shell items, 41 sea urchin items and 2 “other”) and 109 historic artifacts (glass, metal, ceramic and slate items). The “Koloa Field System” observed within the project area was described as, “unique”. The description went on to read, “The field systems of Kōloa are unique, in that they are laid out on almost bare lava rock. Attesting to the degree of planning and labor that went into them, as far as is known, there are no other examples of this type in Hawai‘i. The Kōloa Field System, as surveyed in this report, has remained intact despite encroachment by cattle grazing and development of sugar cane lands”(Kiahuna Archaeological Inventory Survey and Testing of 460 Acres, Volume 1, Archaeological Analysis, January 2004).

The earliest Kīahuna Golf Village sites were carbon-14 dated to the thirteenth through the fifteenth centuries A.D. (SHIP 50-30-10-3841), with sites dated into the sixteenth century (SHIP 50-30-10-3822). According to this inventory survey, The Kōloa Field System continued to expand throughout the eighteenth century A.D., and ceased to function as a field system when sugar cane cultivation took over the existing ‘auwai system for it’s own use.

Jesse Yorck, David Shideler, and Hallett Hammatt (2005) conducted an inventory survey of an approximately 25 acre parcel located northwest of the Sheraton Kaua‘i Resort at the intersection of Po‘ipū and Kapili Roads. Twenty-one archaeological sites consisting of approximately 70 associated features were documented in an area that contained two LCA’s. LCA 3606 (to Kamae) and LCA 10272 (to Makalulu) were both located along the eastern bank of Waikomo Stream, at the western edge of the project area. Approximately 12 enclosures, 14 walls or wall segments, 6 mounds, 8 terraces, 11 C-shapes, 8 modified outcrops, a railroad berm and 12 specialized features were located and documented. The report recommended preservation and limited data recovery of Site 50-30-10-0374 (habitation caves and associated rock-filled areas), and data recovery of Sites -0368, -0369, -0370, -0373,- 0376, and -0947 (the railroad berm). The parcel was characterized as containing mostly pre-contact habitation sites. Some walls were identified as historic ranching-era structures.

John Dockall, et al, (2005) conducted an inventory survey of 6.388 acres located at the Po‘ipū Beach Park, Mauka Preserve. Eight sites consisting of 68 component features were identified and documented. The report recommended preservation of all eight sites. Previous site preservation work had been conducted by members of the *Ka hui malama o Kane I olo uma* group. All features associated with Sites 50-30-10-3886 through 3893 were thoroughly documented with no further work recommended. If the current preservation project by *Ka hui malama o Kane I olo uma* could not continue, additional testing was recommended for Sites 50-30-10-3886K, -3886J, -3888E, -3891A, -3892C, -3893D, and -3893H. In addition, the sites were interpreted as belonging to an agricultural complex that included a fishpond (SIHP Site 50-30-10-3887). The report recommended that each site be interpreted with reference to the entire complex.

3.2.2 Previous Archaeological Studies Associated with the Village at Poipu Project

Previous studies conducted for the Knudsen trust, associated with the proposed Village at Poipu project area indicated on . Hallett H. Hammatt, William Folk, and Mark Stride (1991) conducted an archaeological inventory survey of the proposed Poipulani Golf Course and Residential Development. The project area consisted of 160 acres in eastern Kōloa along the boundary of Kōloa and Weliweli Ahupuaʻa. A total of 75 archaeological sites were documented throughout the project area. It was noted that despite historic modification of the landscape by commercial sugar cultivation and cattle ranching, "significant remnants of a once continuous prehistoric habitation/agricultural complex remain on the property" (Hammatt et al. 1991:i). The habitation and agricultural complex contained features typical of the Koloa Field System, including platforms, c-shapes, walls, enclosures, *ʻauwai*, terraces, and mounds. 8 potential burial sites and two lava tubes possibly containing human burials were also located.

Hammatt et al. (2004) conducted an archaeological inventory survey of an approximately 8 – acre parcel immediately west of the makai portion of the Poipulani project area surveyed by Hammatt et al. (1991). A total of 8 archaeological sites, including platforms, c-shapes, mounds, and walls. The sites were interpreted to be used for permanent and temporary habitation activities in pre-contact times, associated with the Koloa Field System. Limited subsurface testing yielded traditional Hawaiian artifacts and midden, including marine shell, pig and bird bone, adze flakes, coral tools, bone pick, basalt hammerstone, shell bead, and fishhook fragments.

Yorck et al. (2005) conducted an archaeological inventory survey of an approximately 18-acre parcel immediately *makai* of the Poipulani project area surveyed by Hammatt et al. (1991). A total of 16 archaeological sites were documented within the project area, consisting of habitation and agricultural features. Walls, enclosures, c-shapes, mounds, and platforms, typical of the Koloa Field System, were identified. Limited subsurface testing at five sites yielded marine shell, mammal and avian bone midden, volcanic glass flakes, and a basalt hammerstone.

3.3 Background Summary and Predictive Model

From previous archaeological studies and historic accounts it appears that habitation and intensive irrigated agriculture were widespread in central and coastal Kōloa. As an extensive irrigated complex, the Kōloa Field System was used to divert the waters of the Waikomo Stream for taro, native sugar, and fish. As the Judd (1935) account asserts, it is likely that low inland areas were used for less intensive cultivation of patches of sweet potato, *pia*, (arrowroot) and *wauke* (paper mulberry) and the gathering of *hala*, (pandanas fiber) *kukui* nuts (oils having medicinal applications) and other resources. The coastal portion of the *ahupuaʻa* would be a focus for permanent habitation, collection of marine resources, ceremonial activities, and burials. The archaeology of the region also seems to bear out the accuracy of Judd's account.

Chronological analysis from Kōloa, and the two neighboring *ahupuaʻa*, Paʻa and Weliweli, suggests an early initial occupation within the Paʻa Ahupuaʻa of circa A.D. 535 (Walker and Rosendahl, 1990:131). No coinciding early dates have been found within Kōloa Ahupuaʻa, probably due to vagaries of sampling since most of the shoreline area of Kōloa had been heavily impacted by commercial, residential, and resort development. Initial occupation probably was characterized by temporary and/or recurrent occupation. From A.D. 600-1400, settlements in the

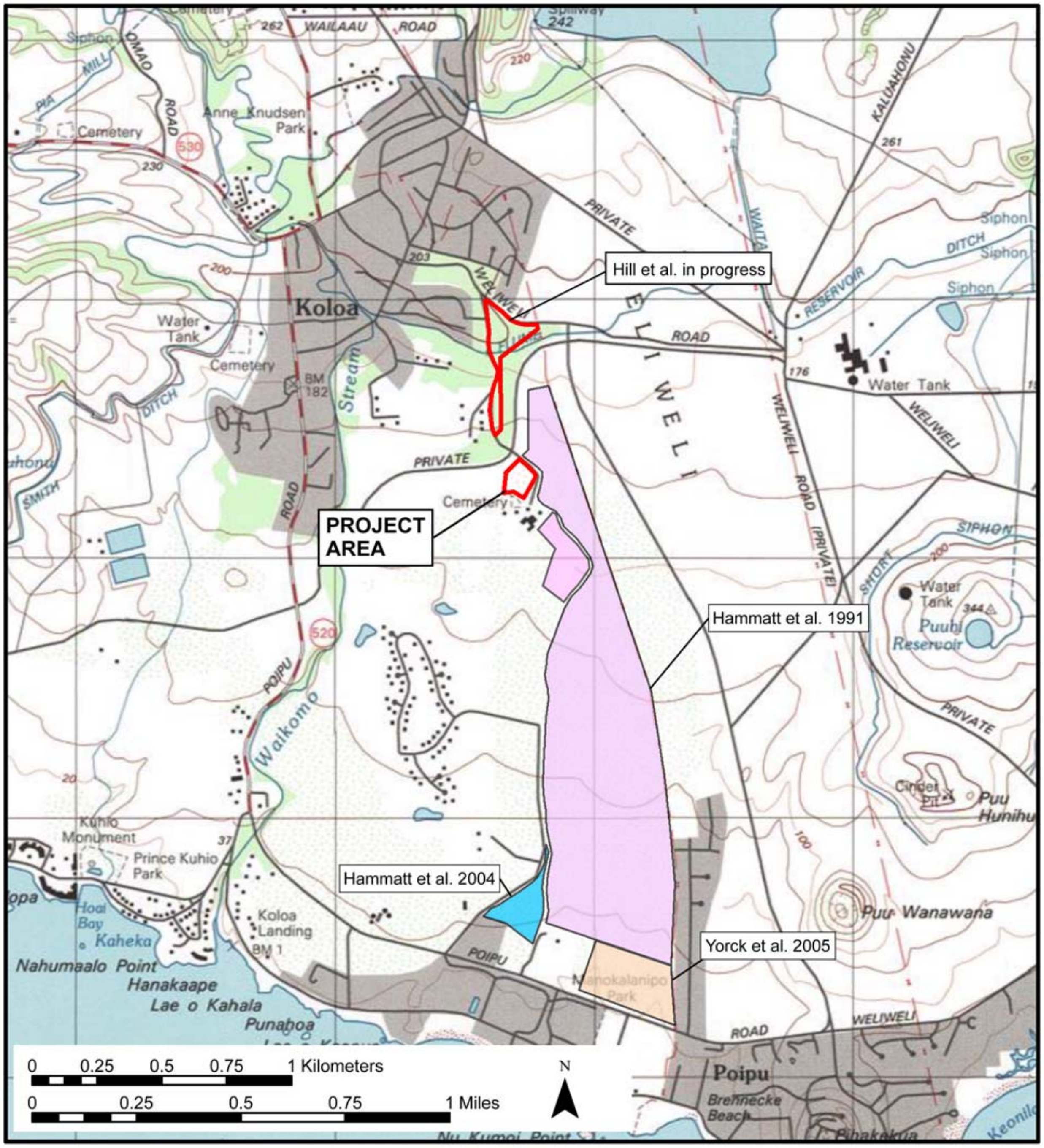

Figure 9. Previous archaeological studies associated with the proposed Village at Poipu project.

Kōloa area were still limited to the coast. By A.D. 1040, lava tubes were used for burial and temporary habitation in the inland areas of Kōloa (Hammatt et al. 1999:7).

In the early historic era (1795-1880), the Kōloa Field System continued in use for foreign trade and was probably further intensified. Sweet potatoes were a main crop for the whaling and merchant ships, and the purchase of pigs, salt, oranges and other items are noted in many ship journals. The documents of the Great Māhele show that by the mid-1800s there were still several traditional farmers within Kōloa who both lived and worked within the area. The individual claims – for both *lo'i* (wetland) and *kula* (dryland) suggest that while traditional farming of taro for subsistence was still taking place, in *kula* lands – sugar cane production for sale to the nearby sugar mill, had begun to dominate the landscape. Of the LCAs within Kōloa, several claim a *kula* planted with cane or a cane field or sugar cane garden. Several also identify cane lands as boundaries for the LCAs. Clearly, *kula* lands were being converted into sugar lands at an increasing rate. Within three years of sugar cultivation by Ladd and Company in 1835, residents in and surrounding Kōloa were quickly moving to adapt to the new economy based on the production of sugar cane. Eventually, most of inland Kōloa was planted with sugar cane and only the most rocky areas, unsuitable for cultivation, survived the dramatic changes in the landscape brought about during the early 20th century.

Historic documentation indicated the current project area was near the eastern extent of the ancient, heavily modified landscape known as the Kōloa Field System. Testimony to the Land Commission associated with land claims for parcels adjacent to the project area indicated land use in the vicinity included *lo'i* (wetland taro cultivation) as well as *kula* (dryland sweet potato cultivation and pasture) lands. Remnants of this traditional agricultural activity, including agricultural planting areas, walls, *'auwai*, and possibly temporary habitation sites, may be present within the project area. Historic maps and photographs also indicated historic ranch related activities within the current project area. A significant stone wall was indicated to traverse the central portion in a generally north-south orientation. Remnants of historic ranch-related activities, including stone walls, may be located within the project area. Intact traditional Hawaiian, as well as historic structures and subsurface deposits are likely to remain relatively undisturbed within the project area due to the apparent lack of development or significant land disturbance within the project area.

Section 4 THE KŌLOA FIELD SYSTEM

The current project area is located at the eastern end of an expansive agricultural system that spread out across the *makai* plain of Kōloa Ahupuaʻa. The features of the present project area can only be comprehended in the larger context of the *ahupuaʻa* system.

4.1 The Kōloa Field System

Often, it has been assumed that the majestic, soil-rich valleys were the preferred environments for the development of irrigated agriculture in the Hawaiian Islands and that the modifications of broad lava plains and slopes for irrigation (e.g. Kōloa on Kauaʻi and Lalamilo on Hawaiʻi Island) came as later developments in response to a need to expand food production. Based on archaeological investigations – including detailed mapping, excavation of habitation and agricultural features, and development of a C14 chronology – over an extended period in the *makai* portions of Kōloa Ahupuaʻa, CSH has been able to define the "*loʻi* lands of Kōloa" as a system – a set of interrelated features harmoniously interacting to form a unified whole. This "Kōloa Field System" extended from Lāwaʻi to Weliweli, covering all of Kōloa Ahupuaʻa below present-day Kōloa Town.

This system developed contemporaneously and in some cases earlier than the well-known valley field networks. Although the principles and the technology applied at Kōloa were similar to the valley networks, the challenging Kōloa landscape led to unique adaptations.

4.2 Environmental Parameters

Consideration of the local topography, climate, and soil characteristics suggest distinct advantages, in comparison to valley environments, for the development of Hawaiian agriculture in the *makai* region of Kōloa. First, there is thin soil over bedrock. This might seem to be a disadvantage but if it is recognized that this thin soil probably supported only thin rooted shrubs with parkland rather than dense forest, the heavy initial labor investment of vegetation clearing would be much less, compared to a densely forested valley environment. Secondly, the solid *pahoehoe* basal rock, 20-30 cm under the silt loam soil, would have led to minimal loss of water through downward percolation, compared to a valley environment. Thirdly, confined valley systems, particularly in the wet valleys of Kauaʻi, could be wiped out or severely damaged by seasonal flooding. In Kōloa, no such problem existed. The Kōloa system is an adaptation and response to the recurrent danger of loss of subsistence production due to flooding. The Kōloa field networks are developed above the flood plain on the well-drained lava plain of the Kōloa volcanic series. In addition, Kōloa is a non-valley leeward environment. Solar radiation is higher than in most valleys and winter sun is not blocked by valley walls. Maturity periods for taro and other staples would be two to four months shorter than in valley environments.

4.3 Topography

The lava plain of Kōloa is not flat, nor is it level. It shows long *mauka/makai*-oriented tongues formed of old lava flows. The *ʻauwai* were kept on these elevated points and could extend for long distances from the primary water source, Waikomo Stream. Some *‘auwai* extended nearly 1.5 miles from the source and most originally extended to the ocean.

4.4 The Kōloa Field System as a Type

Riley (1975:102) and Kirch (1977) have outlined four types of irrigated fields found in Hawai‘i. Type 1 is a simple set of parallel terraces with water flow down the center, overflowing each successive down slope terrace in turn. This is called a “barrage” type system and is considered the most simple. Type 2 involves the construction of an *‘auwai* tapped from the stream which enters the top of a series of terraces. The *‘auwai* ends at the upslope end of the terrace system as the water simply overflows down each successive terrace. Type 3 involves an *‘auwai* paralleling the upslope side of the terrace feeding water to each row of fields. Each row has a separate tap from the *‘auwai*. Type 4 involves two parallel *‘auwai* on separate levels, one downslope from the other, each of which feeds water to separate rows of terraces. The lower *‘auwai* serves as a drainage for the fields above it. This is considered the most highly developed type.

The Kōloa Field System fits none of the types described above. In its abstracted and simplest (and unintensified) form, the Kōloa field system consists of a series of parallel *‘auwai* flowing either on both sides or on top of a lava flow (Figure 10). This type of system would be impossible to construct in a valley environment without an impractical input of labor. It is uniquely adapted to the lava topography of Kōloa. There are no analogies in Hawaiian valleys. The only possible comparison could be to the extensive irrigation system at Lalamilo in Kohala on Hawai‘i Island, where the broad undulating topography required layout of *‘auwai* and fields not typical of a valley environment. Another matter of importance is the sheer size of the Kōloa system. It is known now to have covered over 700 acres and may have been considerably larger before commercial sugar. This would make it one of the largest irrigated systems in the Hawaiian Islands.

Dendritic secondary *‘auwai* branches – or a braiding pattern – would have been progressively added to the main *‘auwai* as the system was intensified. Another form of intensification would be smaller fields. Aqueducted or raised *‘auwai* are one of the most intriguing phenomena of the system (Figure 11). These raised structures are likely labor-intensive responses to the need for more irrigated land in places where water must be routed over low ground. This effort involved the piling of hundreds of cubic meters of sediment and rock, but may have resulted in the ability to irrigate much more than an acre of land. This alone is testimony to the greater productivity of irrigated fields over non-irrigated fields.

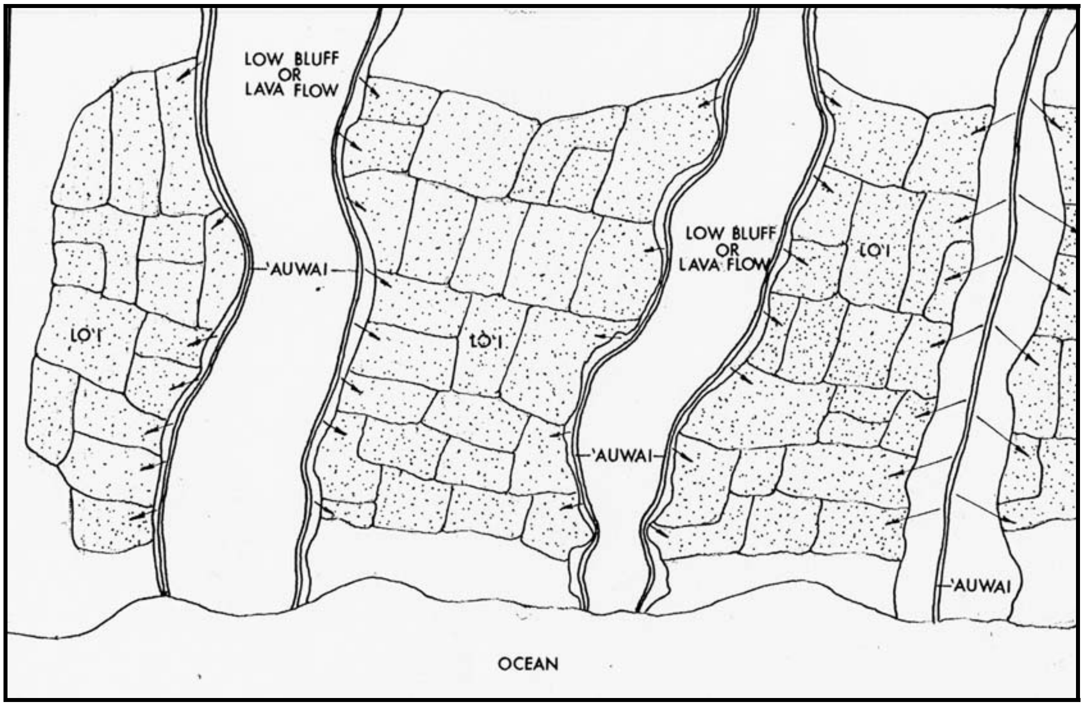

Figure 10. The Kōloa Field System: the basic type schematically represented.

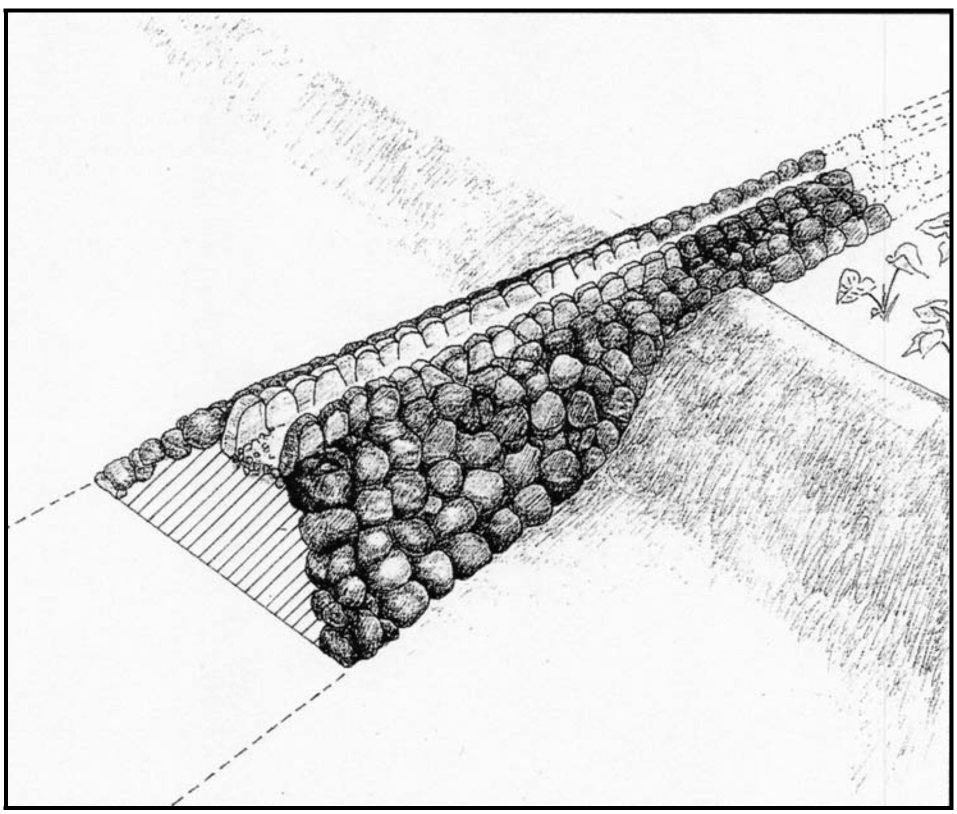

Figure 11 Cross section of a raised *‘auwai* (irrigation ditch).

Section 5 Results of Community Consultation

The community consultation process was completed as part of an accompanying Cultural Impact Assessment for the Village at Po‘ipū project (Mitchell et al. 2005), which included the current 2.8-acre project area project area. Hawaiian organizations, government agencies, community members, and cultural and lineal descendants with ties to the Kōloa area were contacted to: (1) identify potentially knowledgeable individuals with cultural expertise and knowledge of the project area and surrounding vicinity, and (2) identify cultural concerns and potential impacts associated with development in the Village at Po‘ipū project area. The organizations consulted included the State Historic Preservation Division (SHPD), the Office of Hawaiian Affairs (OHA), the Kaua‘i/Ni‘ihau Islands Burial Council, the Kaua‘i Historic Preservation Review Commission, and Hui Malama I Nā Kūpuna O Hawai‘i Nei. In addition, interviews were conducted with five members of the Kōloa community.

The following is a summary of the results of the community contact process conducted by Mitchell et al. (2005). Two interviewees noted that they continue to use the Village at Po‘ipū project area for the traditional cultural practices of gathering *lāpa‘au* for healing, *pule* or prayer and meditation. Three interviewees expressed concerns about Native Hawaiian cultural sites within the project area. Concerns were also expressed over possible burial sites within the Village at Po‘ipū project area and the impact of future development on the local Kōloa lifestyle. Other impacts include increased population, water runoff polluting the fishing and surfing grounds *makai* of the project area, and loss of open quiet space. Two members of Hui Mālama Kāne I Olo Uma stressed that, during traditional Hawaiian times, the present project area was continuous with the *makai* lands (which their organization is caring for) now separated by Pō‘ipu Road. Hawaiian activities – habitation, agricultural, social, and religious – would have been integrated in the now-separated areas.

An ancillary concern expressed by one interviewee, Mr. David Chang, is the habitat of the blind cave spider. Mr. Chang suggests that caves within the project area may contain this and other endangered species.

Section 6 Results of Fieldwork

6.1 Survey Findings

Pedestrian inspection of the project area was completed at 100% coverage. All identified historic properties were located with a Trimble GPS system and plotted on both a USGS topographic map and aerial photograph (Figures 12-13). A total of three historic properties, comprised of six individual features, were identified within the central portion of the project area. State Inventory of Historic Properties (SIHP) No. 50-30-10-3923 Features A-C consisted of a series of historic stone walls. Features A and C were generally oriented north-south, with Feature B oriented east-west. Lands within the eastern portion of the project area, east of the SIHP# -3923 Feature A: stone wall, were relatively level or gently sloping and generally consisted of very rocky terrain. The area did not appear to have undergone any significant land modifications. Lands within the western portion of the project area, west of the SIHP# -3923 Feature C: stone wall, were generally level soil with few surface stones. The area appeared to have been significantly modified by mechanical land clearing activities (i.e. bulldozing), likely associated with pasture improvements.

SIHP# 50-30-10-3924 and SIHP# 50-30-10-3925 were located the central portion of the project area, between the SIHP# -3923 Feature A and Feature C: stone walls. SIHP# -3924 consisted of a stacked-stone platform, adjacent to the SIHP# -3923 Feature A: wall. SIHP# -3925 consisted of two U-shaped agricultural planting areas. SIHP# -3924 and –3925 are interpreted to be pre-contact, traditional Hawaiian constructions associated with the Kōloa Field System. In addition to the formal archaeological features identified, the central portion of the project area also contained numerous informal stone clearing mounds and modified bedrock outcrops. The mounds and modified outcrops were generally constructed on or adjacent to exposed bedrock outcroppings. Construction consisted of rough piling, by hand, of large basalt boulders with basalt cobbles on the surface. The mounds and modified outcrops were of haphazard construction with no facing observed. These informal features are interpreted to be associated with pre-contact, traditional Hawaiian agricultural land clearing activities.

Detailed descriptions of the identified historic properties are as follows:

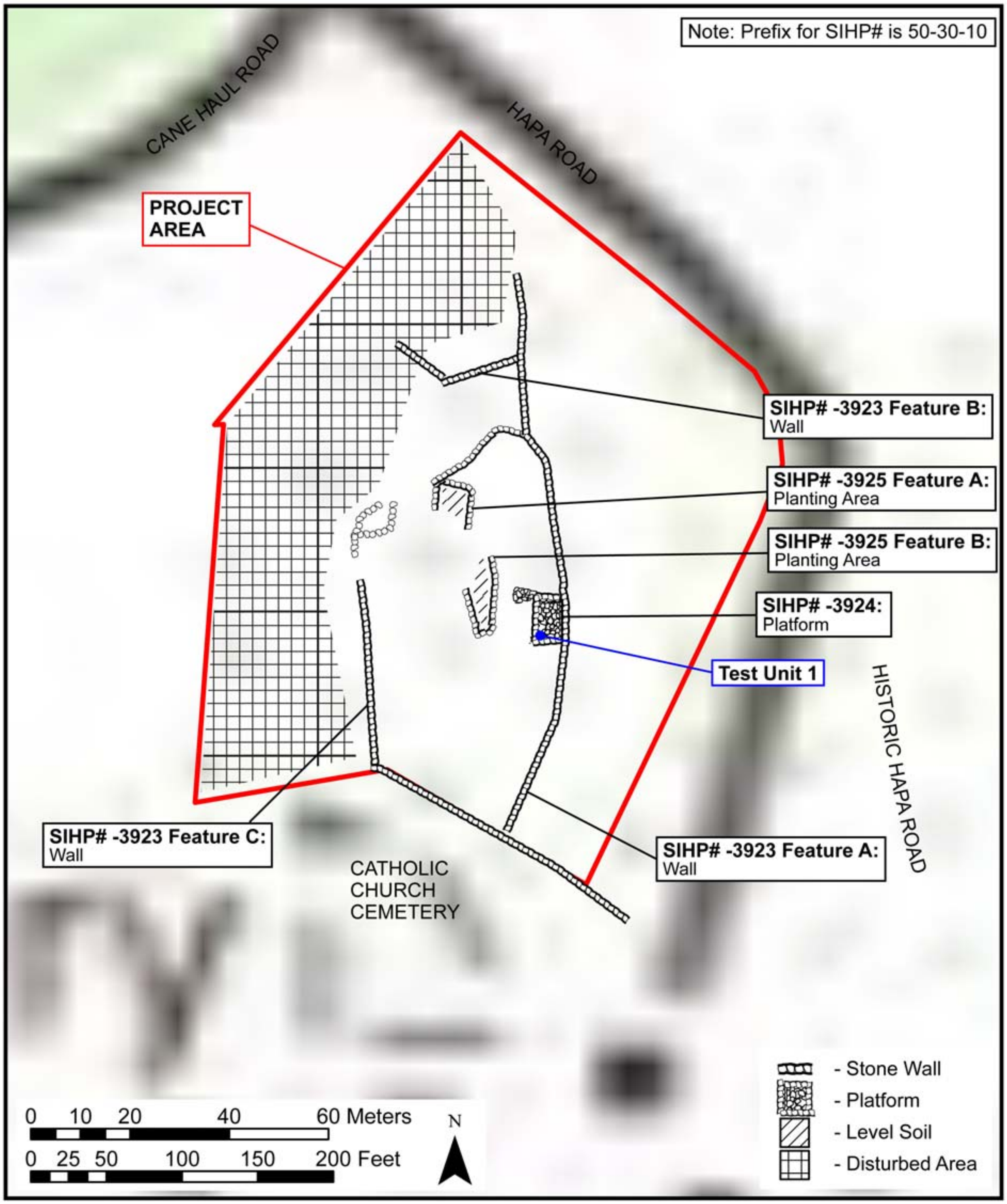

Figure 12. USGS Topographic Map, Kōloa Quad. (1996), showing the locations of historic properties identified within the project area.

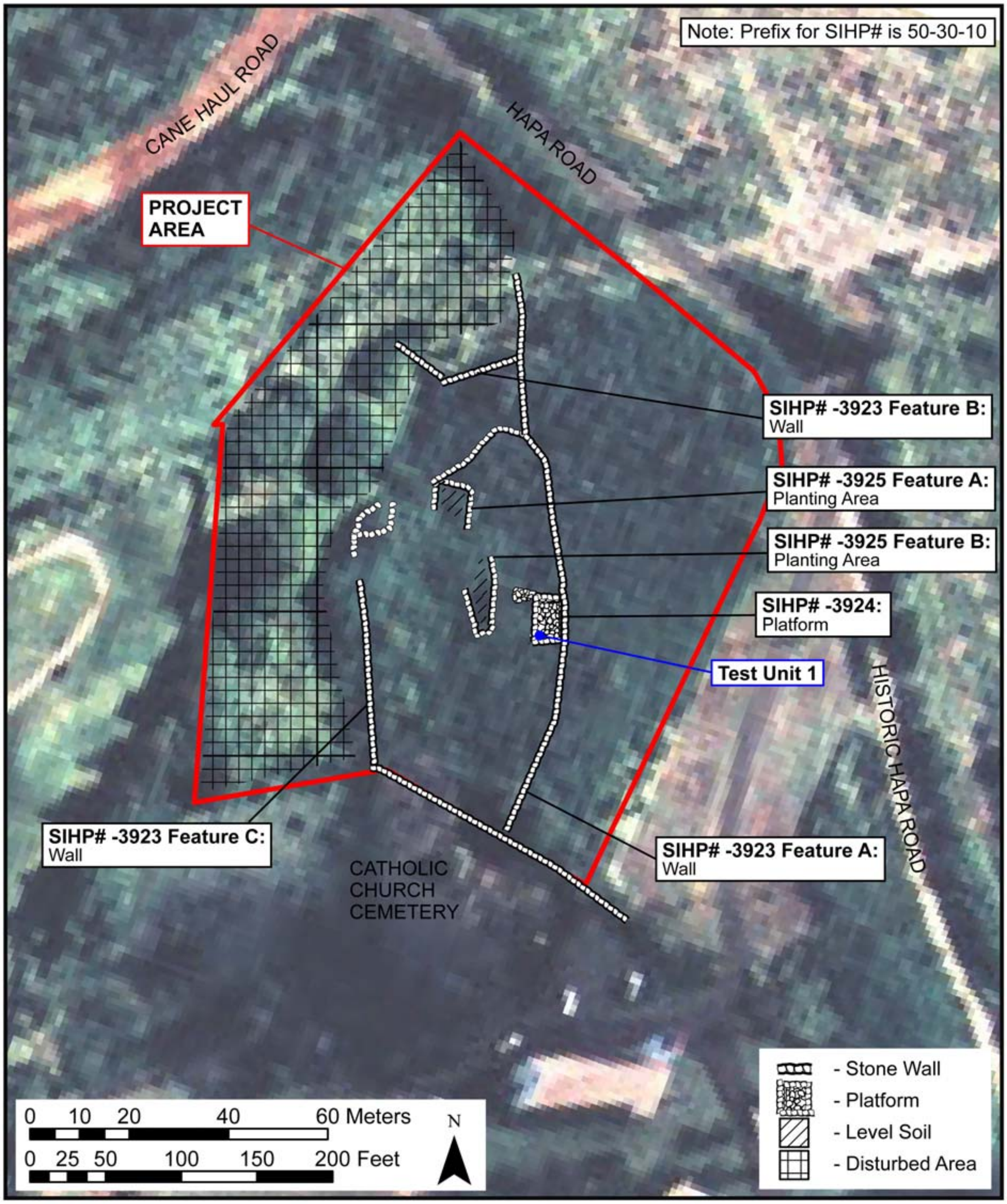

Figure 13. Aerial photograph (2000), showing the locations of historic properties identified within the project area.

6.2 Site Descriptions

6.2.1 SIHP#: 50-30-10-3923

Site Type: Stone Walls
Function: Ranch-Related**,** Land Division
Features: 3
Age: Historic

SIHP# -3923 consisted of three stone walls located within the project area (Figures 12-13). An additional stone wall was located along the southern boundary of the project area. This wall was not given a feature designation as it is likely associated with the Catholic Church cemetery, and therefore not within the current project area. SIHP# -3923 Feature A consisted of an approximately 115 m long portion of a stone wall, running roughly north-south through the central portion of the project area (Figure 14). The wall is constructed of loosely stacked basalt boulders and cobbles, 4-6 courses high. The wall measured a maximum of 1.8 m in height and 0.8 m wide. Large, upright boulders were incorporated into the base of the wall construction. Remnant barbed wire sections were observed strewn along portions of the wall. Feature A wall is depicted on the 1891 Map of Koloa (see Figure 3). At its southern terminus, Feature A intersects with the stone wall along the southern boundary of the project area. At its northern terminus, Feature A had been truncated by land clearing activities.

SIHP# -3923 Feature B consisted of an approximately 27 m long portion of a stone wall, running roughly east-west through the northern portion of the project area (Figures 12-13). The wall is constructed of loosely stacked basalt boulders and cobbles, 4-6 courses high. The wall measured a maximum of 1.5 m in height and 1.2 m wide. Remnant barbed wire sections were observed strewn along portions of the wall. At its eastern terminus, Feature B wall intersects with the northern portion of Feature A wall. At its western terminus, Feature B appeared to have been truncated by land clearing activities.

SIHP# -3923 Feature C consisted of an approximately 35 m long portion of a stone wall, running roughly north-south through the western portion of the project area. The wall is constructed of loosely stacked basalt boulders and cobbles, 4-6 courses high. The wall measured a maximum of 1.3 m in height and 0.8 m wide. At its southern terminus, Feature C wall intersects with the stone wall along the southern boundary of the project area. At its northern terminus, Feature C has been heavily disturbed by land clearing activities. A roughly C-shaped arrangement of boulders was observed at the northern terminus of the wall, but heavy disturbance severely diminished the integrity of the possible feature.

SIHP# -3923 Features A-C are interpreted to be ranch-related cattle walls. The walls function in restricting the movement of cattle. The appearance of the Feature A wall on the 1891 Map of Koloa indicates the walls date to as early as the late 1800s, and likely some time prior to that. The barbed wire observed along portion of the walls indicates the continued usage of the walls into the late-historic and possibly modern era. SIHP# -3923 is in good condition as the walls are generally intact and suffer from little collapse or disturbance.

Figure 14. Photograph of SIHP# 50-30-10-3923 Feature A wall, view to NE.

6.2.2 SIHP#: 50-30-10-3924

Site Type: Platform
Function: Habitation
Features: 1
Age: Pre-contact

SIHP# -3924 consisted of a single, stacked-stone platform located in the central portion of the project area (Figures 12-13). The platform is bordered along its eastern edge by the SIHP# –3923 Feature A stone wall (Figure 15). However, the SIHP# -3924 platform appeared to predate the construction of the historic stone wall. This was evidenced by the foundation of the platform underlying the base of the wall construction. The platform is constructed of loosely stacked basalt boulders and cobbles, 3-4 courses high (Figure 16). The feature is roughly rectangular in shape, measuring 12.5 m by 6 m, with a maximum height of 0.9 m. The southern portion of the platform is the most substantial and well-constructed portion of the feature. The southern and southwestern edges of the feature are well-faced, with an upper level of facing possibly indicating multiple stages of construction. Upright boulders form the base of the southwest corner of the platform, including a particularly angular cornerstone. The surface of the southern portion of the platform is level and well-paved with basalt cobbles. A 1 m by 1 m test unit was excavated within the paved, southwestern portion of the platform (see Section 4.3 Test Excavations Findings). The northern portion of the platform construction is less formal, with facing being replaced by crude piling of stones. The surface of the northern portion of the platform is rough and consisted of piled basalt boulders.

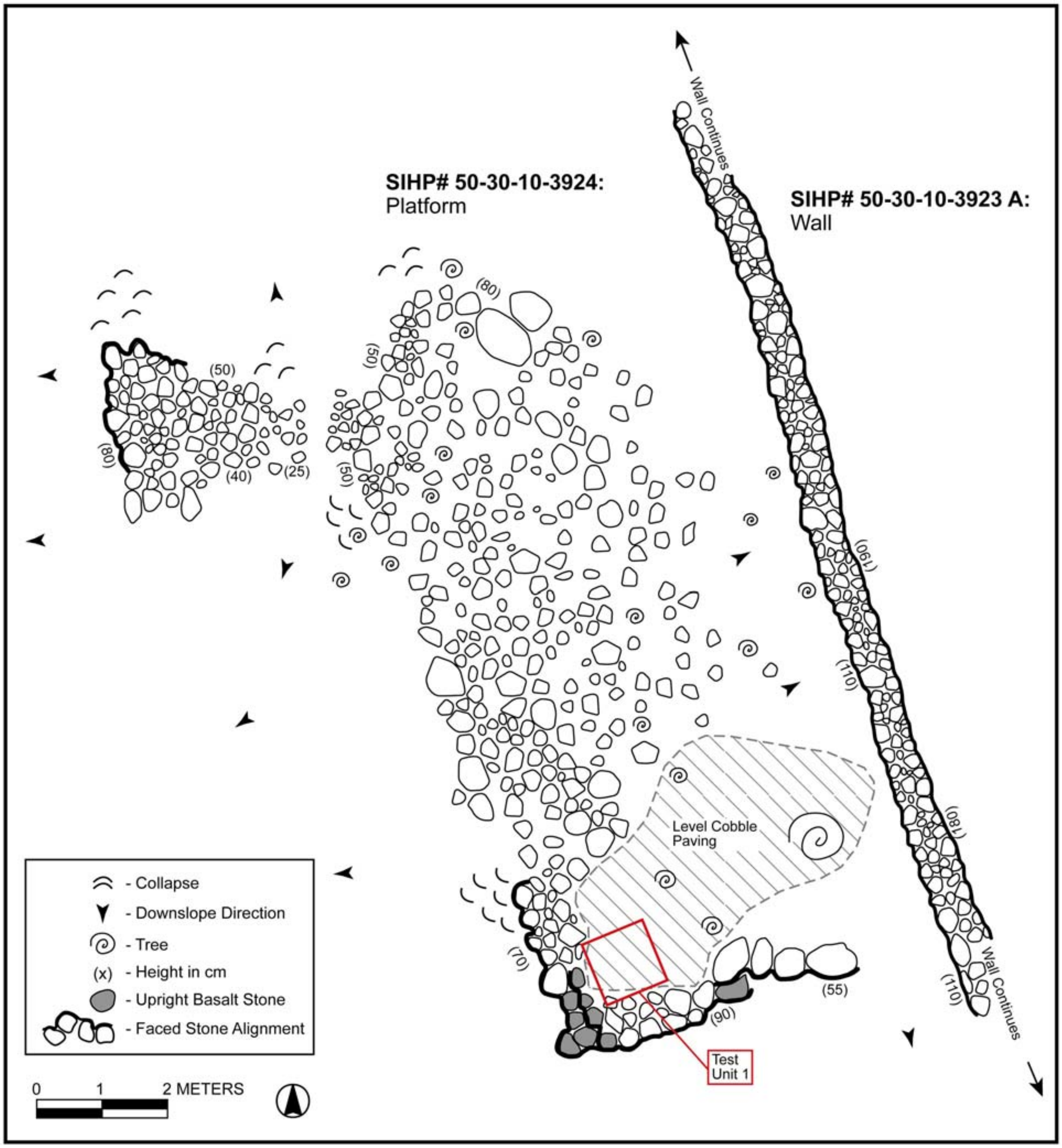

Figure 15. Plan view diagram of SIHP# 50-30-10-3924 platform, including a portion of SIHP# 50-30-10-3923 wall.

Figure 16. SIHP# 50-30-10-3924 platform, southwest corner, view to N.

Figure 17. SIHP# 50-30-10-3924 platform, northwestern extension, view to E.

At the northwest corner of the main platform construction is an extension westward (Figure 17). The extension is constructed of mounded basalt boulders and cobbles, with rough facing observed along the north and west edges. The extension measured 4 m by 2.5 m, with a maximum height of 0.8 m.

SIHP# -3924 platform is interpreted to function as a traditional Hawaiian habitation site. The platform dates to the pre-contact period, based on construction type, the observation of traditional Hawaiian artifacts, lack of historic artifacts, and the results of radiocarbon dating analysis (see Section 7). SIHP# -3924 appears to have been disturbed /modified during the historic period, possibly by removal of stones during the construction of the SIHP# -3923 wall, as well as piling of stones on the feature during stone-clearing pasture improvements. Despite the disturbance to the feature, SIHP# -3924 platform is in good condition, with the southern portion of the platform essentially intact with little disturbance observed.

6.2.3 SIHP#: 50-30-10-3925

Site Type: Planting Areas
Function: Agricultural
Features: 2
Age: Pre-contact

SIHP# -3925 consisted of two agricultural planting areas, located in the central portion of the project area (Figures 12-13). SIHP# -3925 Feature A planting area was composed of a modified bedrock outcrop and a free-standing stone wall, forming a U-shaped planting area (Figures 18-19). The bedrock outcrop, along the western, upslope portion of the planting area, was modified with the addition of roughly piled basalt boulders and cobbles along the length of the outcrop, to a maximum height of 1.1 m. A free-standing stone wall was constructed along the eastern, downslope portion of the planting area, parallel to the modified outcrop upslope. The wall is constructed of loosely stacked basalt boulders and cobbles, 3-4 courses high. The wall measured approximately 10 m long, a maximum of 1 m in height, and an average of 1 m wide. The southern end of the wall is the most substantial and well-constructed, with a maximum width of 2 m and facing along the southern and eastern sides. The wall also connected with the modified outcrop at its northern end, creating a U-shaped planting area within the area bordered by the wall and modified outcrop constructions. The planting area consisted of a level soil area cleared of surface stones, measuring 9 m by 5 m. Level soil areas were also observed immediately upslope and downslope of the enclosed planting area.

SIHP # -3925 Feature B planting area is located approximately 15 m south of Feature A: planting area (Figures 12-13). Feature B consisted of modifications of natural bedrock outcrops, forming a U-shaped planting area. The western portion of the Feature B planting area was bordered by the southern extension of the modified outcrop of Feature A. The bedrock outcrop was modified with the addition of roughly piled basalt boulders and cobbles, to a maximum height of 0.7 m. The eastern portion of the Feature B planting area is bordered by an additional bedrock outcrop, modified with the addition of loosely stacked boulders and cobbles. The stones are stacked 2-3 courses high, to a maximum height of 0.5 m. Faced sections of the modified outcrop were observed. The eastern modified outcrop connected with the western modified outcrop at the southern end of the feature, creating a U-shaped planting area within the area

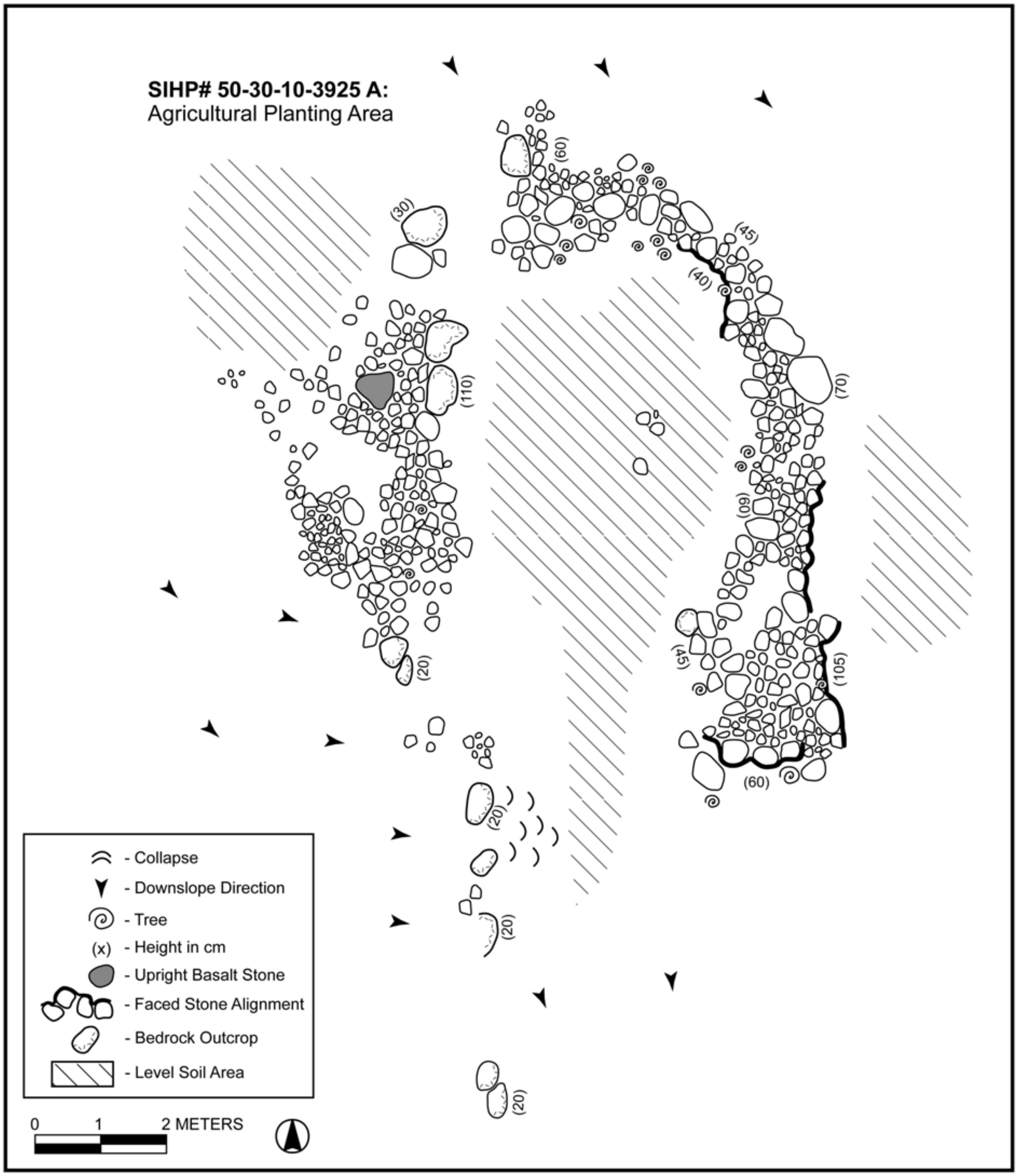

Figure 18. Plan view diagram of SIHP# 50-30-10-3925 Feature A planting area.

Figure 19. SIHP# 50-30-10-3925 Feature A planting area, view to N.

bordered by the modified outcrop constructions. The planting area consisted of a level soil area cleared of surface stones, measuring 15 m by 4 m.

SIHP# –3925 Features A and B are interpreted to function as dry-land agricultural planting areas. The constructions appear to date to the pre-contact period, based on the similarity of construction to typical features of the Koloa Field System, and lack of historic artifacts in the immediate vicinity. The features are in good condition with several areas of intact facing and little modern disturbance observed.

6.3 Test Excavations Findings

6.3.1 SIHP# 50-30-10-3924: Test Unit 1

A 1 m by 1 m test excavation was made within the southwestern corner of SIHP# -3924 platform to better determine the age and function of the feature (see Figure 15). The test excavation was located in the most well-constructed and minimally disturbed portion of the platform. This area was thought to have the highest likelihood of containing intact cultural material.

The surface of the test excavation was a level basalt boulder and cobble pavement (Figure 20). The test excavation revealed the loosely stacked basalt boulder and cobble platform construction extended approximately 60 cm below the top surface of the platform. In general, smaller boulders and cobbles were located near the surface, with larger boulders incorporated into the base of the structure. A single coral cobble was observed incorporated near the surface of the platform construction.

A total of three sediment strata were observed through the excavation of Test Unit 1 (Figure 21). Stratum I consisted of leaf litter and humus accumulated on and within the stacked stone platform structure. Stratum II consisted of a dark brown silty clay loam sediment, incorporating the lower portion of the platform construction, as well as stones underlying the platform. Stratum II generally represented soils developed from material filtering down through the platform construction. Due to the density of cultural material, Stratum II was divided into three excavation levels, Level 1 at 40-50 cmbd, Level 2 at 50-60 cmbd, and Level 3 at 60-70 cmbd. Stratum II, Level 1 contained 6.4 g of charcoal, 5 indigenous artifacts, 46.4 g of *kukui* endocarps, and 1.1 g of mammal midden. Indigenous artifacts included a broken polished basalt adze fragment, basalt awl, basalt flake, and two coral abraders. Stratum II, Level 2 contained 18.4 g of charcoal, 43.9 g of *kukui* endocarps, and 2.0 g of marine midden. Level 2 also contained 1 human tooth (pre-molar). Stratum II, Level 3 contained 18.9 g of charcoal, 1 indigenous artifact, 14.4 g of *kukui* endocarps, and 3.9 g of mammal midden. Indigenous artifacts included a coral abrader. Stratum III consisted of a dark yellowish brown silty clay sediment, consisting of saprolite developed from the decomposition of the underlying basalt bedrock. The test excavation terminated at clearly sterile Stratum III sediments.

Following the test excavation, the excavated area was reconstructed as closely as possibly to its original state. The human tooth recovered from the Stratum II sediments was reburied in the western corner of the excavation, at approximately 70 cm below the surface of the platform. Detailed sediment descriptions are as follows:

Figure 20. Test Unit 1, pre-excavation (above) and post-excavation (below) photographs.

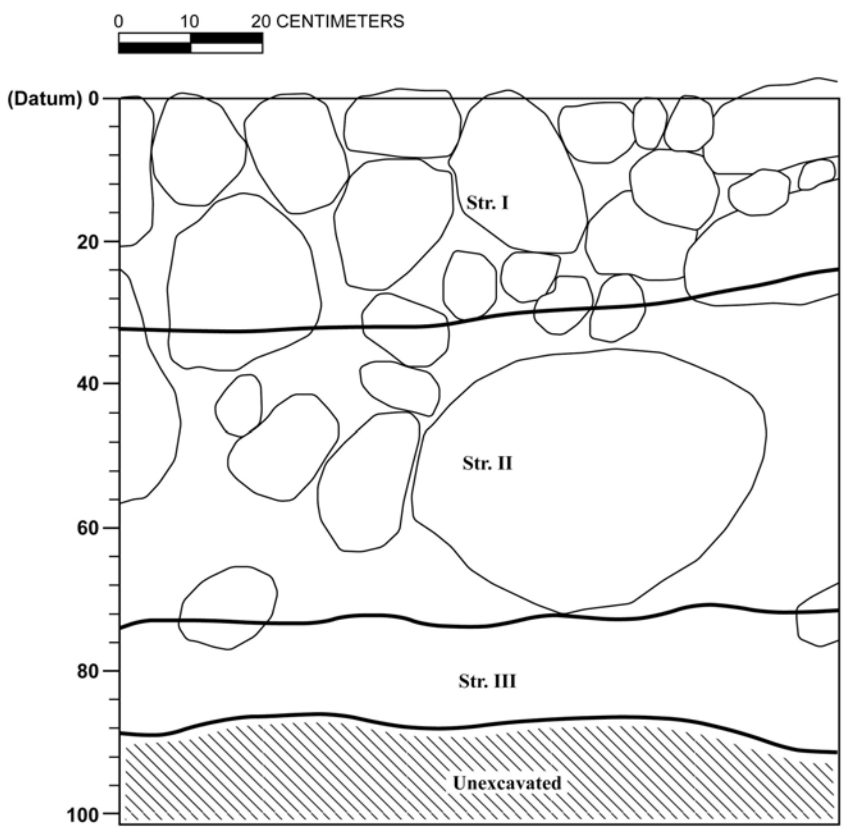

Figure 21. Test Unit 1 photograph (above) and stratigraphic profile (below), east wall.

Strata	Depth (cmbd)	Description
Stratum I	0-30	Leaf litter and humus accumulated on and within the stacked stone platform structure; Lower Boundary (LB) is abrupt, smooth.
Stratum II	30-75	7.5YR 3/2 dark brown silty clay loam; moderate, medium blocky structure; dry, loose consistency; slightly plastic; no cementation; terrestrial origin; contains abundant charcoal, kukui, marine shell and fish midden; basalt flakes; and one isolated human tooth; LB is abrupt, smooth.
Stratum III	75-BOE	10YR 4/6 dark yellowish brown silty clay; weak, medium blocky structure; dry, loose consistency; slightly plastic; no cementation; terrestrial origin; sterile saprolite; no cultural material observed; LB is below base of excavation.

Section 7 Results of Laboratory Analyses

Test Unit 1 at SIHP# -3924 contained a total of 111.7 g of midden, 7 artifacts, and 43.7 g of charcoal. The midden collection (Table 3) contained 2.0 g of marine midden, consisting of a small amount of invertebrate (mollusk) shell refuse and two fragments of *scaridae* (parrot fish) grinding teeth. The limited amount of marine midden was isolated within Stratum II, excavation level 2. The midden collection contained 109.7 g of terrestrial midden, consisting primarily of 104.7 g of *kukui* endocarps. 5.0 g of mammal midden, consisting of *Canis familiaris* (dog) and unidentified small mammal bone fragments, were also recovered. The terrestrial midden was generally concentrated in the Stratum II, excavation levels 1 and 2, with a decreased amount in the deepest excavation level (i.e. excavation level 3).

A total of 7 indigenous artifacts were recovered from Test Unit 1 (Table 4). A single coral cobble manuport (Acc. # 1) was recovered from within the stacked stone construction of the SIHP# -3924 platform. The remaining artifacts were recovered from within the sediments underlying the platform construction (i.e. Stratum II). Three artifacts were composed of fine-grain basalt, including a possible awl (Acc. # 2), a basalt flake (Acc. # 3), and a broken polished adze fragment (Acc. # 4) (Figure 22). The three remaining artifacts were coral abraders (Acc. #s 5-7).

A total of 43.7 g of charcoal was recovered from Test Unit 1 (Table 5). The recovered charcoal was relatively abundant and consisted of medium to large charcoal flecks and chunks. The charcoal was generally concentrated in the Stratum II, excavation levels 2 and 3, with a decreased amount in the shallowest excavation level (i.e. excavation level 1). The charcoal recovered from excavation level 3 was submitted to Beta Analytic, Inc. for radiocarbon dating analysis (Sample KOLO50-1, Beta –208398) (Appendix A). Radiocarbon dating analysis yielded a calibrated 2-sigma date range of A.D. 1470-1660 (95.4% probability). Analysis also yielded multiple radiocarbon calibration curve intercepts of A.D. 1530, 1560, and 1630. The calibrated date range and calibration curve intercepts are within the pre-contact period.

Table 3. Catalog of Marine and Terrestrial Midden Recovered from SIHP# -3924, Test Unit 1.

	Weight (g)			
Depth (cmbs)/Stratum	**40-50/II**	**50-60/II**	**60-70/II**	**TOTAL**
Class Gastropoda				
Unidentifed/Other	0.0	0.5	0.0	0.5
TOTAL MOLLUSCA	**0.0**	**0.5**	**0.0**	**0.5**
TOTAL INVERTEBRATE MIDDEN	**0.0**	**0.5**	**0.0**	**0.5**
Class Osteichthyes				
Scaridae	0.0	1.5	0.0	1.5
TOTAL CHORDATA	**0.0**	**1.5**	**0.0**	**1.5**
TOTAL MARINE MIDDEN	**0.0**	**2.0**	**0.0**	**2.0**
Class Mammalia				
Canis familiaris	1.1	0.0	0.0	1.1
Small-to-Medium Mammal	0.0	0.0	3.9	3.9
TOTAL MAMMALIA	**1.1**	**0.0**	**3.9**	**5.0**
Kukui Endocarps	46.4	43.9	14.4	104.7
TOTAL TERRESTRIAL MIDDEN	**47.5**	**43.9**	**18.3**	**109.7**
TOTAL MIDDEN	**47.5**	**45.9**	**18.3**	**111.7**

Table 4. Catalog of Indigenous Artifacts Recovered from SIHP# -3924, Test Unit 1.

Acc. #	Stratum	Depth (cmbd)	Pieces	Length	Width	Thickness	Weight (g)	Material Type	Comments
1	I	0-40	1	7.0	3.3	2.6	55.2	coral	manuport
2	II	40-50	1	4.7	4.2	1.7	46.2	fine grain basalt	possible awl
3	II	40-50	1	6.6	4.2	1.9	67.3	fine grain basalt	flake
4	II	40-50	1	6.1	3.7	2.5	84.1	fine grain basalt	broken polished adze fragment
5	II	40-50	1	2.8	0.6	0.3	0.5	coral	abrader
6	II	40-50	1	2.8	1.5	1.0	3.4	coral	abrader
7	II	60-70	1	3.1	1.9	0.8	3.1	coral	abrader

Table 5. Catalog of Charcoal Recovered from SIHP# -3924, Test Unit 1.

Acc. #	Stratum	Depth (cmbd)	Weight (g)	Comments
C-1	II	40-50	6.4	
C-2	II	50-60	18.4	
C-3	II	60-70	18.9	KOLO 50-1 for analysis
Total Charcoal			**43.7**	

Figure 22. Photographs of select traditional Hawaiian artifacts recovered from SIHP# -3924, Test Unit 1.

Section 8 Summary and Interpretation

A pedestrian inspection of the project area was completed at 100% coverage. A total of three historic properties, comprised of six individual features were identified within the project area. SIHP# 50-30-10-3923 Features A-C consisted of a series of three loosely stacked stone walls. The stone walls are interpreted to be historic ranch-related cattle walls.

SIHP# 50-30-10-3924 consisted of a single loosely stacked stone platform. Subsurface testing within the platform revealed the presence of midden, charcoal, and traditional Hawaiian artifacts. Radiocarbon dating analysis of charcoal recovered from SIHP# -3924 yielded a calibrated date range of A.D. 1470-1660. Traditional Hawaiian artifacts recovered from the test excavation included a basalt flake, basalt awl, broken polished basalt adze fragment, and three coral abraders. A single human tooth (premolar) was also recovered from sediments underlying the platform construction. The platform was interpreted to be a pre-contact, traditional Hawaiian habitation site. The assemblage of artifacts representing active tool usage may indicate the site was a work area or temporary habitation shelter associated with agricultural activities in the vicinity. The presence of human teeth in habitation deposits is not unusual. There was no evidence of an *in situ* human burial within the SIHP# -3924 platform.

SIHP# 50-30-10-3925 Features A and B consisted of two agricultural planting areas. The planting areas were constructed with U-shaped walls and modified outcrops creating cleared and level soil planting areas. The planting areas are interpreted to be pre-contact, dry-land agricultural planting areas. In addition to the three formal historic properties identified, numerous informal stone clearing mounds and modified bedrock outcrops were located throughout the undisturbed portions of the project area. These features are interpreted to be associated with pre-contact agricultural clearing.

The historic properties identified within the project area represent two distinct periods in the history of Kōloa. SIHP# 50-30-10-3924 and SIHP# 50-30-10-3925 represent habitation and agricultural elements of the expansive traditional Hawaiian agricultural system known as the Kōloa Field System. The project area is located near the eastern extent of the Kōloa Field System, which formerly spread out across the *makai* plain of Kōloa Ahupua‘a. During the historic period, as commercial sugar cultivation replaced traditional forms of agriculture in Kōloa, areas not suitable for sugar cultivation were used as pasture for grazing cattle. SIHP# 50-30-10-3923 stone walls represent remnants of the ranching era in Kōloa.

Section 9 Significance Assessments

9.1 Significance Assessments

Each historic property identified within the project area was evaluated for significance according to the broad criteria established for the National and State Registers of Historic Places (Table 6). The five criteria are:

A Associated with events that have made an important contribution to the broad patterns of our history;

B Associated with the lives of persons important in our past;

C Embodies the distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value;

D Have yielded, or is likely to yield information important for research on prehistory or history;

E Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property, or due to associations with traditional beliefs, events or oral history accounts – these associations being important to the group’s history and cultural identity.

SIHP# 50-30-10-3923 consisted of a series of three stone walls located within the project area. The walls were interpreted to be historic, ranch-related cattle walls. SIHP# -3923 is evaluated as being significant under Criterion D (have yielded, or may be likely to yield information important in prehistory or history) of the State and National Register of Historic Places.

SIHP# 50-30-10-3924 consisted of a single stacked-stone platform located in the central portion of the project area. The platform was interpreted to be a pre-contact, traditional Hawaiian habitation structure. SIHP# -3923 is evaluated as being significant under Criterion D of the State and National Register of Historic Places.

SIHP# 50-30-10-3925 consisted of two agricultural planting areas. The planting areas were interpreted to be pre-contact agricultural features. SIHP# -3923 is evaluated as being significant under Criterion D of the State and National Register of Historic Places.

Table 6. Historic Properties Identified within the Project Area.

SIHP# 50-30-10	Site Type	Features	Posited Function	Age	Significance	Work Accomplished	Mitigation Recommendation
-3923	Stone Walls	3	Ranch-Related	Historic	D	L, M, P, D	No Further Work
-3924	Platform	1	Habitation	Pre-contact	D	L, M, P, D, T	Data Recovery
-3925	Planting Areas	2	Agricultural	Pre-contact	D	L, M, P, D	Data Recovery

L=Located with GPS, M=Mapped, P=Photographed, D=Described, T=Limited Subsurface Testing

Section 10 Project Effect and Mitigation Recommendations

10.1 Project Effect

Proposed development within the current project area, a portion of the proposed Village at Po‘ipū project, included subdivision of the entire parcel for residential houselots. Minimally, land disturbing construction would include grubbing, grading, dwelling construction, and excavations for the installation of subsurface utilities. The proposed residential houselot development project will adversely affect three significant historic properties (i.e. SIHP# 50-30-10-3923, -3924, and -3925) located within the project's APE. CSH's project specific effect recommendation is "effect, with mitigation commitments." The recommended mitigation measures will reduce the project's adverse effect to these significant historic properties.

10.2 Mitigation Recommendations

To reduce the proposed project's adverse effect on significant historic properties, the following mitigation measures are recommended. The mitigation measures should be completed prior to any land disturbing activities within the project area. An archaeological data recovery program, in the form of controlled archaeological excavations, is recommended for SIHP# 50-30-10-3924 (platform) and 50-30-10-3925 (agricultural planting areas). Data recovery excavations will generate additional information regarding the age and function of the significant historic properties. In addition, due to the presence of a human tooth located during the test excavation within SIHP# -3924, there is the possibility that additional human remains may be present. Prior to the commencement of the data recovery program, a Data Recovery Plan must be submitted to the SHPD for review and approval.

No further work is recommended for SIHP# 50-30-10-3923 (stone walls). Sufficient information regarding the location, function, age, and construction methods of the SIHP –3923: stone walls has been generated by the current study.

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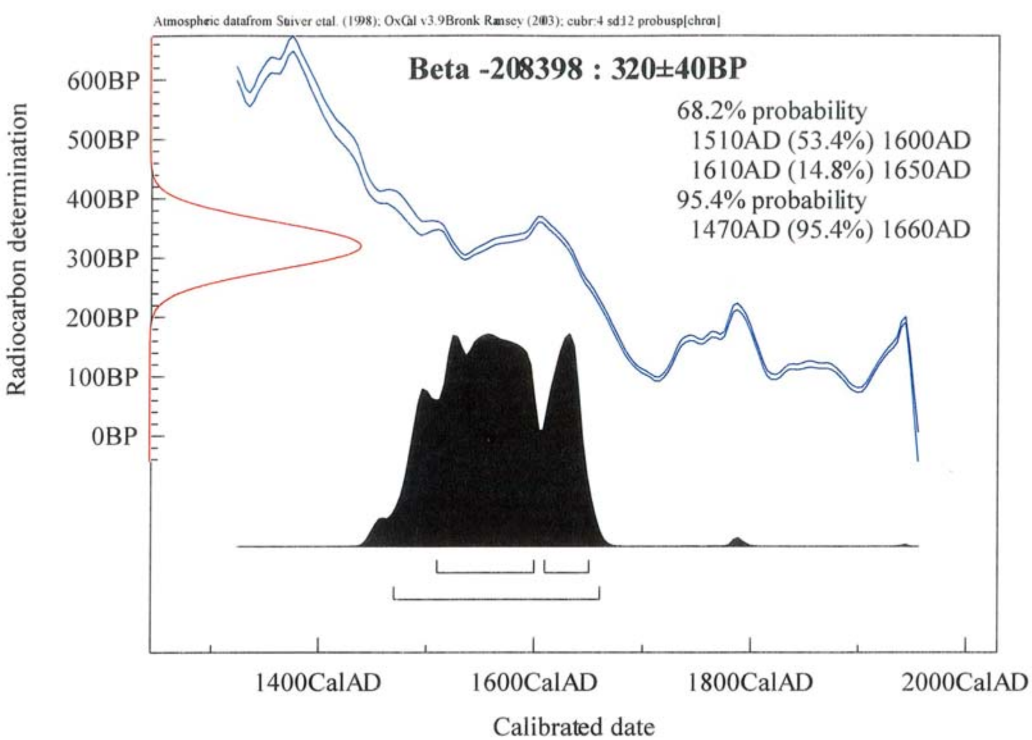
Appendix A: Radiocarbon Dating Analysis

Dr. Hallett H. Hammatt | Report Date: 10/5/2005

Cultural Surveys Hawaii | Material Received: 9/6/2005

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 208398	320 +/- 40 BP	-25.2 o/oo	320 +/- 40 BP

SAMPLE : KOLO50-1
ANALYSIS : Radiometric-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1460 to 1660 (Cal BP 490 to 290)



Appendix G

JOHN WAIHEE
GOVERNOR OF HAWAII

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

DEPUTIES

KEITH W. AHUE
MANABU TAGOMORI
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AQUACULTURE DEVELOPMENT PROGRAM
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CONSERVATION AND RESOURCES ENFORCEMENT
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FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

September 9, 1991

Peter Nakamura, Director
Planning Department
County of Kauai
4280 Rice Street
Lihue, Hawaii 96766

Dear Mr. Nakamura:

SUBJECT: Historic Preservation Review -- Revised Third Draft -- Data Recovery and Preservation Plan for the Poipulani Development Area (Hammatt, Cultural Surveys Hawaii, July 1991)
TMK: 2-8-13: 1; 2-8-14: 1,2, 3,4 & 19
Weliweli, Koloa, Kauai

We have received the above revised plans, which address our concerns sent to the consulting archaeologist on March 27, 1991. There are still some minor corrections that need to be made. However, we can accept the plans with the understanding that the consulting archaeologist will submit the corrected pages in two weeks from the date of this letter.

Previously, we concluded that the project area had been adequately surveyed and that all historic sites had been likely found, totalling 75 sites. 12 sites are considered to be "no longer significant" because adequate amounts of their significant information were recorded during the survey; 63 sites are still considered significant. We agreed with the mitigation commitments -- preservation of 12 sites (with some data collection to aid preservation planning) and archaeological data recovery of 51 sites.

The plans reviewed in this letter provide a detailed scope of work for data recovery and the interim protection parts of preservation. The long-range preservation concerns (interpretation, landscaping, maintenance, etc.) are not in this plan, and a document covering these long-range preservation concerns must be approved for the preservation plan to be considered complete.

It is our recommendation that the project will have "no adverse effect" on significant historic sites, with the agreed upon mitigation commitments and the implimentation of the acceptable data recovery and interim protection plan. To ensure that the agreed upon mitigation is properly executed, we believe that the following conditions must be attached to any approved permit:

1. The applicant shall preserve the agreed 12 historic sites: 86, 900, 913, 926, 934, 938, 939, 946, 947, 953, 966, and 967. [Five of these sites are probable burial sites (919, 926D, 927, 936, 940), and they will undergo archaeological testing, according to the data recovery plan, to determine if they are burials. If no burials are found, these sites shall be shifted to the archaeological data recovery work. If burials are found, these sites will be

preserved under the preservation plan. Each time a burial is discovered, the State's Historic Preservation Division must be notified immediately, the burial shall remain in place, the site shall be restored in its original condition, and the site findings shall be fully documented.]

2. All sites to be preserved shall be protected during construction according to the Interim Preservation Measures, with buffer zones around each site to be preserved and to be approved in writing by the State's Historic Preservation Division and the County's Planning Department. Buffer zones for burial sites must be presented to DLNR's Kauai Island Burial Council for their comments to the State Historic Preservation Division. A pre-construction meeting to inform construction crews about the historic sites shall occur prior to any construction activity commencing. These steps must be verified by the State Historic Preservation Division and the County of Kauai, Planning Department.

3. A detailed long-range preservation plan for all sites to be preserved shall be approved by the State Historic Preservation Division and the County of Kauai Planning Department, prior to the completion of the project. It must be executed and verified by the State Historic Preservation Division and the County of Kauai, Planning Department, prior to completion of the project. This plan must include interpretation, public access, landscaping and maintenance concerns.

4. The applicant shall undertake archaeological data recovery of the 51 significant historic sites within the project area according to the approved detailed data recovery plan. This work must be executed prior to land alteration or construction work in the area. The successful execution of this work, including the submittal of an acceptable final report, must be verified by the State Historic Preservation Division and the County of Kauai Planning Department prior to land alteration in the area.

5. If burials are found during construction, they shall be treated under Chapter 6E-43, H.R.S.. Construction must stopped in the immediate vicinity of the finds, until mitigation work is completed.

The needed corrections for this plan are on pages 14, 15, and 26. The corrections are underlined. The total number of sites should be 63 significant sites, <u>eleven</u> will be ... (page 14). The total of <u>5</u> (page 15). There are <u>6</u> probable burial features (926D, 940, 936, 953, 919, 927) (page 26. — COMPLETED 9/91

If you have any questions regarding this review, please contact Ms. McMahon at 587-0006.

Sincerely,

Ross Cordy

for DON HIBBARD, Administrator
State Historic Preservation Division

cc: Kauai Island Burial Council
Hal Hammatt, CSH
Loren Baxter

Data Recovery and Preservation Plan

for the Po'ipulani Development Area

Prepared by

Hallett H. Hammatt, Ph.D.

Prepared for

Po'ipulani Development Corporation

by

Cultural Surveys Hawaii

January 1991

Revised July 1991

Table of Contents

List of Tables

I. Introduction

This Data Recovery Plan was prepared to follow the recently completed Archaeological Inventory Survey of the proposed Golf Course and Residential Development (Hammatt et al., 1990, revised Jan. 1991). The information on archaeological is extracted from the Survey Report with input from Mr. Loren Baxter of Po'ipulani Development Co. as to developments plans - which specific areas are to be impacted and to what extent. As recommended in the 1990 Survey Report mitigation of impact should be handled by preservation of selected archaeological sites with data recovery of those to be impacted by the development construction. This plan details the recommended steps for data recovery and site preservation.

A. Development Plans

The site is planned to be developed as an 18-hole golf course with 92 single family residential lots. Such a development leaves the developer with some latitude in design. Numerous modifications have been made to the original plans as additional sites and information have been discovered. Although it would be desirable to preserve all sites, design and economic criteria dictate the destruction and/or partial demolition of some of the sites.

The disposition of each site as recommended in this plan has taken into consideration the significance assessments and general treatment recommendations as presented in the Inventory Survey Report.

II. Archaeological Sites and Significance

A. Significant Sites

Table 1 contains a summary list of archaeological sites with significance assessments. Of a total of 75 archaeological sites identified, 12 are classified as no longer significant (NSL) or not significant (NS) because they are not considered worthy of preservation and information valuable to history or prehistory has already be collected. This leaves 63 significant archaeological sites on the property. As to specific criteria for significance 61 sites are designated significant under Criterion D (likely to yield information important to prehistory or history) and 10 are classified under Criterion C (Excellent examples of site types). A total of 8 sites are classified as probable burials and are grouped under Criterion E. Table 2 shows the sites listed by presumed functional categories and age.

Table 1

SUMMARY LIST OF ARCHAEOLOGICAL SITES

Field No	State No	Description	Work Done	Significance	Preliminary Mitigation	Work To Do
CSH135	86	(Bennett) Habitation Platform	Surveyed& Mapped 1985	C, D	Pres D	None
CSH4	900	Habitation Platform	Surveyed	C, D	Pres, Int.	Possible Test for C14
CSH5	901	Ag.mounds,wall	Surveyed 1985	D	Data Rec.	Map
CSH6	902	C-shaped shelter	Surveyed 1985, Tested 1985, C14 samples collected	D	Data Rec.	No Excavation No Mapping Date C14 Sample
CSH7	903	C-shaped shelter	Surveyed collapsed	D	Data Rec. 1985	Map
CSH8	904	C-shaped shelter small	Surveyed 1985	D	Data Rec.	Map
CSH9	905	C-shaped shelter	Surveyed 1985	D	Data Rec.	Map
CSH101	906	Ag.features, walls mounds	Surveyed 1990	NLS	None	None
CSH102	907	L-shaped wall	Surveyed 1990	NLS	None	None
CSH103	908	Modified Outcrop	Surveyed mapped 1990	D	Data Rec.	Map Test
CSH104	909	Modified Outcrop	Surveyed mapped 1990	D	Data Rec.	Map Test
CSH105	910	C-shaped shelter	Surveyed 1990	NLS	None	None
CSH106	911	C-shaped shelter remnant	Surveyed 1990	NLS	None	None
CSH107	912	C-shaped shelter remnant	Surveyed 1990	NLS	None	None
CSH108		(field # not assigned)				

Field No	State No	Description	Work Done	Significance	Preliminary Mitigation	Work To Do
CSH109	913	Ag/Habitational Complex w/ assoc. 'auwai & platform	Surveyed mapped 1990	C,D	Pres. Int.	Test for C14
CSH110	914	Ag.mound	Surveyed mapped 1990	NLS	None	None
CSH111	915	L-shaped terrace	Surveyed mapped 1990	D	Data Rec.	Test
CSH112	916	Mound	Surveyed mapped 1990	NLS	None	None
CSH113	917	U-shaped mound	Surveyed mapped 1990	D	Data Rec.	Test
CSH114	918	Habitation platform	Surveyed mapped 1990	D	Data Rec.	Test Possibly Expanded Excavation
CSH115	919	Large mound, internal features	Surveyed mapped 1990	D,E*	Data Rec. Pres.Burial?	Test for burial
CSH116	920	'Auwai	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench
CSH117	921	'Auwai section	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench
CSH118 (Part of 929)						
CSH125	922	'Auwai section	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench
CSH119A-C	923A-C	Ag.walls,shelter	Surveyed mapped 1990	D	Data Rec.	Map
CSH119D	924	C-shape, shelter	Surveyed mapped 1990	D	Data Rec.	Map Test
CSH119E	925	Enclosure	Surveyed mapped 1990	D	Data Rec.	Map Test
CSH120	926	Ag.fields & ranching complex	Surveyed mapped 1990	C, D (E* Fea. D)	E* Fea.E test forPres.Burial? Data Rec.	Test for Burial
CSH121A	927	Mound	Surveyed mapped 1990	D,E*	Data Rec. Pres.Burial?	Test for Burial

Field No	State No	Description	Work Done	Significance	Preliminary Mitigation	Work To Do
CSH121B	928	Mound	Surveyed mapped 1990	D	Data Rec.	Test
CSH122	929	'Auwai section	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench
CSH123	930	'Auwai section	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench
CSH124	931	'Auwai section	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench
CSH125	932	Walls, enclosure	Surveyed mapped 1990	D	Data Rec.	Test
CSH126	933	Wall	Surveyed mapped 1990	NLS	None	None
CSH127A	934	Wall	Surveyed mapped 1990	C	Pres. Int.	None
CSH127B	935	Mound	Surveyed mapped 1990	NLS	None	None
CSH128	936	Mound with paving	Surveyed mapped 1990	D,E*	Data Rec. Pres.Burial?	Test
CSH129	937	Wall	Surveyed mapped 1990	NLS	None	None
CSH130	938	Wall & 'auwai	Surveyed mapped 1990	C,D	Pres. Int.	None
CSH131	939	Lava tube shelter	Surveyed mapped 1990	D,E*	Pres.Burial	Test Deposits
CSH132A	940	Mound, shelter & wall	Survey mapped 1990	D,E*	Data Rec. Pres. Burial?	Test
CSH132B (See 940)						
ARCH421	941	'Auwai	Surveyed 1986 mapped 1990	D	None	None
CSH133	942	Wall & habitation-al enclosure	Surveyed mapped 1990	D	Data Rec.	Test Possible Expanded Excavation
CSH134	943	'Auwai section	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench

Field No	State No	Description	Work Done	Significance	Preliminary Mitigation	Work To Do
CSH6	944	Ag mounds & modified outcrops	Surveyed mapped 1990	NLS	None	None
CSH136	945	Corral & 'auwai Ag walls	Surveyed mapped 1990	D	Data Rec.	Cross-Section Trench
CSH137	946	Lava tube	Surveyed mapped 1990	C,D,E	Pres.Burial Test deposits	Test
CSH138	947	Railroad berm	Surveyed mapped 1990	C,D	Pres. Int.	None
ARCH420	948	Walled Complex	Surveyed 1978 Resurveyed 1990	C,D	Data Rec.	Test
ARCH420A	949	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Test
ARCH420B	950	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map, Inspect for Deposits
ARCH420C	951	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map, Inspect for Deposits
ARCH421	952	Platform	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Test, Possible Expanded Excavation
ARCH422	953	Platform	Surveyed 1978 Resurveyed 1990	D,E*	Pres.Burial	Map Test
ARCH423	954	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map Test
ARCH423A	955	Mound	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map Test
ARCH424A	956	C-shaped shelter	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map
ARCH424B	957	C-shaped shelter & Platform	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map, Test?
ARCH424C	958	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map Test

Field No	State No	Description	Work Done	Significance	Preliminary Mitigation	Work To Do
ARCH424D	959	C-shaped shelters	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map Test
ARCH425A	960	Shelters & low wall	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map Test?
ARCH425B	961	Shelters & cupboard	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map Test?
ARCH426	962	Enclosure	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map
ARCH427	963	Ag. enclosure & low mounds	Surveyed 1978 Resurveyed 1990	NLS	None	None
ARCH428	964	C-shaped shelter	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map
ARCH429	965	2 adjoining C-shaped shelters & wall	Surveyed 1978 Resurveyed 1990	D	Data Rec.	Map Test?
ARCH430A	966	Ag. Complex, walls lo'i	Surveyed 1978 Resurveyed 1990	C,D	Pres. Int.	None
ARCH430B	967	C-shaped shelter	Surveyed 1978 Resurveyed 1990	D	Pres. D.	None
ARCH836	968	C-shaped shelters enclosure & wall	Surveyed 1978 Resurveyed 1985 Tested 1985 (C14 collected)	D	Data Rec.	Map Date C14 Sample
CSH103	969	'Auwai	Surveyed Mapped 1990	D	Data Rec.	Cross-Section Trench
CSH104	970	Rocky Ag area	Surveyed mapped 1990	NLS	None	None
ARCH423	971	'Auwai	Surveyed 1978	D	Data Rec.	Cross-Section Trench
-	972	'Auwai	Surveyed 1978 mapped 1990	D	Data Rec.	Cross-Section Trench
ARCH430A	973	'Auwai	Surveyed 1978 mapped 1990	D	Data Rec.	Cross-Section Trench

CODES FOR CRITERIA FOR SITE SIGNIFICANCE

NS	Not Significant
NLS	No Longer Significant
A	Site reflects major trends or events in the history of the state or nation
B	Site is associated with the lives of persons significant in our past
C	Site is an excellent example of a site type.
D	Site may be likely to yield information important in prehistory or history.
E	Site has cultural significance; probable religious structures (shrines, heiau) and/or burials present

* Signifies site is only a possible burial or religious feature.

CODES FOR PRELIMINARY MITIGATION

Pres. Int. = Preservation with Interpretation

Pres. Burial = Preservation of Burial

Pres. D = Preservation for information content

Data Rec. = Site to be data recovered (may or may not be chosen for actual testing or excavation - depending on research strategy)

Table 2: Po'ipulani Sites by Functional Categories and Age

State Site No.	Description	PH	TH	'Auwai	Ag.site	Burial	Cave	Other	Pre-historic	Post Contact	Comments
50-30-10 86	Habitation Platform	x							x	x	
50-30-10 900	Habitation Platform	x							x		
50-30-10 901	Ag. mounds, wall				x				x		
50-30-10 902	C-shaped shelter		x						x		
50-30-10 903	C-shaped shelter collapsed		x						x		
50-30-10 904	C-shaped shelter small		x						x		
50-30-10 905	C-shaped shelter		x						x		
50-30-10 906	Ag. features, walls, mounds		x		x				x		
50-30-10 907	L-shaped wall		x		x				x		
50-30-10 908	Modified outcrop		x						x		
50-30-10 909	Modified outcrop		x						x		
50-30-10 910	C-shaped shelter		x						x		
50-30-10 911	C-shaped shelter remnant		x						x		
50-30-10 912	C-shaped shelter remnant		x						x		
50-30-10 913	Ag/Habitation Site w/ 'auwai & platform		x	x	x				x		
50-30-10 914	Ag. mound				x				x		
50-30-10 915	L-shaped terrace		x						x		
50-30-10 916	Mound				x				x		
50-30-10 917	U-shaped mound				x				x		
50-30-10 918	Habitation Platform	x							x	x	
50-30-10 919	Large mound, internal features		x			x(?)			x		
50-30-10 920	'Auwai			x					x	x	
50-30-10 921	'Auwai section			x					x	x	
50-30-10 922	'Auwai section			x					x	x	
50-30-10 923	Ag. walls, shelter		x		x				x	x	
50-30-10 924	C-shape, shelter		x						x		
50-30-10 925	Enclosure		x						x		
50-30-10 926	Ag. fields & ranching complex		x(G)	x(F)		x(D)			x	x	
50-30-10 927	Mound				x	x(?)			x		
50-30-10 928	Mound				x				x		
50-30-10 929	'Auwai section			x					x	x	
50-30-10 930	'Auwai section			x					x	x	
50-30-10 931	'Auwai section			x					x	x	
50-30-10 932	Walls, enclosure		x		x				x		

PH - Permanent Habitation TH - Temporary Habitation

Table 2: Po'ipulani Sites by Functional Categories and Age

State Site No.	Description	PH	TH	'Auwai	Ag.site	Burial	Cave	Other	Pre-historic	Post Contact	Comments
50-30-10 933	Wall				x				x	x	
50-30-10 934	Wall				x					x	
50-30-10 935	Mound				x				x		
50-30-10 936	Mound w/ paving				x	x?			x		
50-30-10 937	Wall				x						
50-30-10 938	Wall & 'auwai			x	x				x	x	
50-30-10 939	Lava tube shelter		x			x	x		x	x	
50-30-10 940	Mound shelter & wall				x	x?			x		
50-30-10 941	'Auwai			x					x	x	
50-30-10 942	Wall & habitation enclosure	x			x					x	
50-30-10 943	'Auwai section			x					x	x	
50-30-10 944	Ag mounds & modified outcrops				x				x		
50-30-10 945	Ag. walls & 'auwai			x	x				x	x	
50-30-10 946	Lava tube	x				x	x		x		
50-30-10 947	Railroad berm							x		x	
50-30-10 948	Walled complex		x		x				x	x	
50-30-10 949	Enclosure		x						x		
50-30-10 950	Enclosure				x					x	
50-30-10 951	Enclosure		x							x	
50-30-10 952	Platform	x							x		
50-30-10 953	Platform	x				x			x		
50-30-10 954	Enclosure	x							x		
50-30-10 955	Mound								x		
50-30-10 956	C-shaped shelter		x						x		
50-30-10 957	C-shaped shelter & platform		x						x		
50-30-10 958	Enclosure		x						x		
50-30-10 959	C-shaped shelters		x						x		
50-30-10 960	Shelters & low wall		x						x		
50-30-10 961	Shelters & cupboard		x						x		
50-30-10 962	Enclosure			x					x		
50-30-10 963	Ag. enclosure & low mounds				x				x		
50-30-10 964	C-shaped shelter			x					x		
50-30-10 965	'2 adjoining C-shaped shelters & wall			x	x				x		

Table 2: Po'ipulani Sites by Functional Categories and Age

State Site No.	Description	PH	TH	'Auwai	Ag.site	Burial	Cave	Other	Pre-historic	Post Contact	Comments
50-30-10 966	Ag. complex, walls, lo'i				x				x		
50-30-10 967	C-shaped shelter		x						x	x	
50-30-10 968	C-shaped shelters, enclosure & wall		x						x		
50-30-10 969	'Auwai			x					x		
50-30-10 970	Rocky Ag. area				x				x		
50-30-10 971	'Auwai			x					x	x	
50-30-10 972	'Auwai			x					x	x	
50-30-10 973	'Auwai			x					x	x	

B. Age of Sites and Depth of Subsurface Cultural Deposits

There is some comparative information on which to base an estimate of time range for the Po'ipulani sites. Excavations were conducted in the Kīahuna area west of the Po'ipulani project area and east of Waikomo Stream. Some dating results are available for this project. The age range for the Po'ipulani sites can be based on what we know of broad prehistoric early historic patterns on Kaua'i and in Hawai'i in general. To date, the earliest C14 dated occupation on the south coast of Kaua'i is from cultural layers at Keoneloa Bay in Pa'a with age ranged from as early as A.D. 220 - 690 representing intermittent short-term beach occupation (Rosendahl & Walker: 1990:313). Intensive development of irrigated lo'i came after A.D. 1100-1200 A.D. and the non-flood plain, pahoehoe terrain of Kōloa would have been one of the later systems in the sequence. The earliest irrigated agriculture here probably post-dates A.D. 1400 and the system was probably not intensified until the late prehistoric period and continued in use to supply whaling ships in the Post-European Contact Period. The caves probably contain older cultural deposits, but most of the prehistoric surface features will post-date 1400 and will probably cluster around the A.D. 1700-1770 range.

A series of 18 C14 dates from Kīahuna reinforces this interpretation. The cave sites show nearly continuous occupation from 1,000 A.D. onwards. And the surface sites associated with agricultural development post date 1400-1500 A.D. There is, however, one early date for a habitation platform A.D. 890±170 but this is considered too early for the development of intensive irrigated agriculture. So far at Kīahuna there is one dated _'auwai_ with an age range of 1325-1430 A.D. This age appears to mark an early construction phase of the _'auwai_ and is considered a reasonable age for the onset of irrigated planting.

We expect the Po'ipulani portion of this agricultural complex to be slightly later, given its greater distance from Waikomo Stream - the course of water for virtually all of this ancient enterprise.

As for the depth of deposits under sites (except for caves), based on the similar sites in the Kīahuna and Kukuiula, maximum depth to bedrock will probably be in the range of 30-60 cm. Cultural deposits within caves are expected to be one meter or deeper depending on the amount of historic illuviation.

III. Plans for Preservation

A. Introduction

Because of the nature of the development it is possible to preserve a number of archaeological sites from direct development impact. In terms of numbers - of the total of 63 significant sites, eleven will be completely preserved and 1 will be partially preserved (Railroad berm Site 947). In addition, the disposition of 6 of the sites is not determined at this time pending archaeological testing to determine if human burials occur within them. If burials are found then these sites will be preserved.

B. Preservation Plans

The following preservation measures will be taken

1. Physical Preservation of all or parts of the most well-preserved agricultural/habitation complexes which best represent former Hawaiian use of the land. These complexes are Sites 913 and 966.
2. Physical Preservation of well-preserved, excellent examples of habitation sites. Included in this category is Site 86, recorded by Bennett in the late 1920s, and Site 900, another habitation platform.
3. Physical Preservation of both lava tube cave sites, Sites 939 and 936, not only because of their archaeological significance but because they almost certainly contain burials. All areas above the tube chambers should be kept as open space.
4. Physical Preservation of all other sites which are likely to

contain burials or which testing shows to contain burials. Site 953 should definitely be preserved. This site will be tested to establish if there is a burial in the rock fill of the platform.

5. Physical Preservation of portions of Site 947, the railroad berm. The berm is best preserved at its western end.
6. Physical Preservation of some of the well-preserved walls. The best examples are found at Sites 934 and 938. These walls are representative of the past use of the land and reflect the unique character of the traditional Kōloa landscape.
7. Physical Preservation of any other sites which can possibly be incorporated into the development landscaping and designated as open space.

C. Preservation of Burial Sites

There are 8 sites designated as possible or probable burial sites as mentioned in the Inventory Survey. Three of the five probable burial sites will be preserved. Included in this list is Site 939 which shows exposed human bone and is therefore a confirmed burial site. Site 953 is a highly probable monument platform burial and will be tested to establish if it is a burial site. The Site 926 lava tube is also a probable burial site which will be preserved. The remaining 5 probable burial sites will be tested. If burials are located in them then they will be preserved.

D. Interim Preservation

All sites designated for preservation will be marked with a fence or highly visible barrier to make them visible for avoidance by mechanical equipment during construction. The location of these barriers should be approved by State and County Agencies. An archaeologist will be present during fencing to insure appropriate location of the fences. One or more archaeologists will be on site during all grading, grubbing or other construction activities in the vicinity of the preserve areas which are likely to pose potential impact to them. Immediate steps should be taken to prevent vandalism to all existing sites, particularly rock robbing. Signs should be posted at all vehicle access points expressly forbidding rock collecting except by authorized parties.

E. Buffer Zones

Included in these flagged areas will be buffer zones of at least 50 feet. The exact width of the buffer zone beyond 50 feet will depend on the nature of the site and its cultural or scientific importance.

F. Long-Term Preservation

At the completion of construction the exotic vegetation should be cleared from the site with hand tools. Any further steps of improvement stabilization, interpretation, etc. should proceed according to a long-term preservation plan approved by

F. Long-Term Preservation

At the completion of construction the exotic vegetation should be cleared from the site with hand tools. Any further steps of improvement stabilization, interpretation, etc. should proceed according to a long-term preservation plan approved by State and County agencies. At this point, we would envisage at least vegetation clearing, planting around some of the sites (agricultural walls for example), and signs explaining the significance of some of the sites. Access to the 2 lava tube sites should be limited by protective fencing or grates at the entrances. At this point 5 of the sites designated for preservation are considered appropriate for interpretation. These interpretive programs which may include signs, brochures etc. will be detailed in the long-term preservation plan.

IV. Data Recovery

A. Introduction

Clearly, no extensive data recovery is appropriate for the sites to be completely preserved although some will be tested. Those sites which cannot be saved in their entirety will be subjected to data recovery.

Of the total 63 significant sites, ten sites are to be preserved and do not require more than testing to address specific questions. This leaves 53 sites to be the subject of a data recovery program more than testing to address specific questions.

The sites destined for data recovery are summarized according to site types as follows:

B. Permanent Habitation Sites

Four of the permanent habitation sites are included in the list for data recovery. Included are Sites 918, 942, 952 and 954. Site 942 corresponds to a historic land court award and is quite likely to have a historic era component which may provide significant information on early trade and economic patterns.

C. Temporary Habitation Sites

Temporary habitation sites in the lower Kōloa irrigated fields are typically C-shaped structures and curved wall shelters which are dispersed around agricultural areas, particularly in rocky unusable topography. There are 26 such sites. In most cases 1-2-meter excavation trenches would be sufficient to recover all associated cultural material. Since most of these shelters are in rocky areas soil deposits are expected to be thin (less than 20 cm. in depth). Sites with thin or non-existent cultural deposits will not be excavated but will be closely examined and a detailed scaled map will be made. This mapping and examination will constitute data recovery. Some of these sites contain hearth deposits and emphasis would be placed on sampling sites likely to contain hearths and associated soil deposits, and collecting charcoal for C14 dating. Given the general lack of charcoal deposits in the agricultural features themselves, a chronology of use of the nearby field shelters may be the best way of dating agricultural usage in specific areas.

D. Agricultural Sites

These include mounds, walls, terraces and most importantly, *'auwai*. Intact *'auwai* should be cross-sectioned at various localities to expose bank and ditch deposits for stratigraphic study and collection of datable material. The depth and stratigraphic variation of the deposits which were removed from the *auwai*(s) during construction and clearing and piled on the adjacent bank, can give clues to the length of use and perhaps the changing nature of the sediments carried by the *'auwai*. There is also a chance of finding datable charcoal in the deposits which provide excellent chronology for irrigated agriculture. In a testing program of *'auwai*(s) in the nearby Kukuiula area, buried stone linings have been found in some examples. These, and other buried features, can indicate sequences of construction and improvement through time. All _'auwai_ sections to be impacted will be cross-section trenched by hand or backhoe unless they are sitting directly on bedrock with no soil deposits.

To a lesser extent these same information can be gained through cross sectioning of agricultural walls and terraces. The primary focus would be to recover datable material and to document construction technique and sequences (if present).

E. Burial Sites

There are 6 possible burial sites which will be tested (Sites 919, 926D, 927, 936, 940, and 953). If burials are found, the remains will be left in place, the trenches backfilled and the sites preserved.

F. Lava Tube Sites

Both lava tube sites (939 and 946) are to be preserved. However, it is considered important to collect at least minimal data from these deposits before development because of the value of these archaeological sediments for chronological and paleoenvironmental interpretations.

G. Miscellaneous Sites

Portions of Site 947 - the historic era sugar train bed are to be impacted by development. Demolition of portions of this structure would be an excellent opportunity to document the construction method. Given the late age of this berm (1890s), nevertheless, little is known of the details of construction. A simple cross section of the one or more sections would allow documentation of the methods used. This information would compliment a continuing search of historical sources. The cross section will be performed by backhoe during the 'auwai trenching.

V. Research Goals and Methods

What emerges as important research questions which apply to the Po'ipulani data recovery efforts are as follows (A-C):

A. Chronology

At the present time, there are no quantitative dates available for the project area. However, a series of 18 C14 dates have been obtained for the adjacent Kīahuna project which contains a similar pattern of land use and habitation. Kīahuna dates show cave occupation at or after 1000 A.D. and surface permanent habitation sites dating to 1500 or after. One surface site now destroyed was dated to 890-1170 A.D. from a sample collected in 1979. This date is considered anomalously early for surface sites in the area. An _'auwai_ cross-section trench, excavated in 1979, yielded charcoal from the base dating 1325-1430 A.D. The general pattern appears to be early occupation of caves and the beginning of irrigated agriculture around 1400 A.D. Chronological information from habitation and agricultural features in the Po'ipulani area could help expand and refine this tentative chronology. This chronology could be refined at the upper end through dating of historical debris, bottles, nails, ceramics, coins, etc., within historic sites associated with agricultural activities.

B. Origin and Development of Irrigated Agriculture in Kōloa

It is probable that the development of the field systems occurred over a considerable span of time and a certain amount of evolution of design and configuration took place. This would affect subsistence and settlement patterns. Information related to this question would be obtained not only from dated materials but the study of stratigraphic relations of agricultural and habitation features. Although soil deposits are fairly thin in many areas it should be possible to locate superimposed agricultural features indicating different phases of development, i.e. stone terraces under earthen terraces, terraces under walls or habitation sites over fields. Through interpretation of these data, it may be possible to reconstruct construction sequences and to infer patterns from these sequences. Field work to address this question would involve backhoe trenching of auwai sections and other agricultural features as well as hand excavation in selected areas.

C. Post Contact Acculturation and Economic Change

This question particularly applies to the modification of the agricultural system to produce cash crops for the merchant ship trade centered from Kōloa Landing from the mid-19th Century onwards. The question may be elucidated through excavation and dating of historic occupation sites and discerning the final alterations in the agricultural fields before abandonment. A search of historic records for crops produced, their location and tonnage exported may also be of value.

D. **Coordination with Other On-going Projects**

Cultural Surveys Hawaii is involved with 2 other projects in the immediate vicinity which contain similar sites of the same archaeological complex. This complex stretches on both sides of Waikomo Stream and includes the Kīahuna and Kukuiula project areas. Cultural Surveys Hawaii is attempting to coordinate information from all three of these areas to construct a general picture of what may be termed the Kōloa Field System. Because of the proximity and similarity of the project areas, the information gathered from one will be complimentary and directly relevant to the others. This is particularly true in the case of chronology of origin and development. It is predicted, for example, that the areas directly adjacent to Waikomo Stream on the west and east would have been the earliest to be developed for irrigated agriculture. One would expect expansion to proceed away from the stream on either side. The development of the prehistoric system in the Po'ipulani area may be one of the later phases in the growth of this complex. This again underscores the need for quantitative dates from a wide range of features.

VI. Field and Laboratory Methods

A. Sampling of Sites

It is not realistic or productive to excavate each of the sites on the data recovery list. However, all 51 sites will be subjected to further investigation - either testing or further mapping. Excavation will concentrate on sites whose testing will serve to address the research goals mentioned above. In addition, because of planned development with eventual grubbing and grading the six sites suspected of containing human burials will be tested. Sites which are to be preserved will not be excavated, except for testing to address specific questions. The two cave sites to be preserved should be briefly tested for chronological and environmental data.

The following sampling strategy will guide the field work.

B. Agricultural Sites and Features

1. One cross section trench will be placed in each of the *'auwai* sections slated for data recovery. *'Auwai*(s) with no soil deposits will not be cross-sectioned. Two or three trenches will be placed along the lengths of the longer *auwai* sections. The banked sediment on the side of the *auwai*(s) will be of particular interest in stratigraphic and chronological interpretations. At least some of the trenches will be done by backhoe.
2. Three to four test trenches in agricultural fields representing samples of *kula* fields, traditional *lo'i*

and _lo'i_ later planted in cane. In deeper soil areas trenches will be dug by backhoe.

3. Cross section trenches through field walls, stone terraces and earthen mounds in 3-5 spatially separated localities to recover possible stratigraphic succession of agricultural features.

C. Habitation Sites

1. All 4 suspected permanent habitation sites will be tested, with more extensive excavation of two. The selection of the sites for more complete excavation will depend on the results of the testing. The habitation sites with the longest and deepest stratigraphic sequence will be chosen for complete excavation.
2. At least half (approximately 13) of the smaller shelters (C-shape, U-shape, L-shape, etc.) will be tested with complete excavation of 2-3. In the others, data recovery will consist of further mapping. Both isolated shelters in fields as well as those clustered around major habitation sites will be chosen for testing and excavation. These sites will be chosen for testing and excavation on the basis of depth of soil deposits and probability of associated features such as hearths.

D. Burial Sites

There are 6 probable burial features (926D, 940, 936, 953, 919, 927) within the Po'ipulani project area not presently on the preserve list. These and Site 953 (a preserve site) will be tested to address research questions and to determine presence or absence of burials and to estimate numbers of individuals. If burials are found the sites will be preserved.

E. Caves

There are two cave sites in the Po'ipulani project area; a small lava tube shelter (939) and a long tube site in the mauka portion of the project area (946). Both of these caves are suspected burial sites and are to be preserved. The entrances will be sealed or closed to allow only authorized access to prevent looting. Data recovery is therefore not necessary. However, brief testing of the cave sediments (a single 1 meter square) will be conducted to collect chronological and paleontological data. Faunal samples will be submitted to Dr. Alan Ziegler for identification.

F. Excavation Methods

The following methods will be used in the excavation of all trenches:

1. screening of all sediments through 1/8 inch mesh screen;
2. recovery of all artifacts and shell and bone midden;
3. recovery of all charcoal both as "in situ" samples and

from the screen;

4. recording of stratigraphy by scale drawing of at least one profile in each 1-meter square trench;
5. all trenches will be excavated to culturally sterile soil deposits or bedrock;
6. the sites chosen for testing excavation will be mapped to scale showing all internal features and excavated trenches.

G. **Laboratory Methods and Report Preparation**

This phase of work will involve the following:

1. Identification and cataloging of artifactual material including both historic as well as prehistoric forms. Artifacts will be measured with representative samples drawn and/or photographed to scale.
2. Identification, weighing, and analysis of midden material to genus and species. This information will be tabulated for each layer within each stratigraphic unit within each site.
3. Preparation, submittal and dating of datable samples (volcanic glass and charcoal).
4. Dating and identification of historic era artifacts.
5. Preparation and submittal of special faunal remains to Dr. Alan Ziegler.

H. Report Preparation

The final report will contain the following:

1. An in-depth presentation of each research question incorporating prior archaeological and historical studies in the Kōloa area.
2. Site findings, maps, descriptions, surface collections for each site will be discussed separately. Site maps, and stratigraphic profiles will be included.
3. A separate section on artifact analysis.
4. A separate section on midden analysis.
5. A separate section on volcanic glass and radiocarbon and historic period artifact chronology.
6. A summary chapter which re-evaluates the findings on each research question.
7. References
8. Appendices
   a. Master Artifact Catalog
   b. Volcanic Glass Dating Lab Report

I. Report Review Procedures

A draft report will be submitted to Po'ipulani Development Co., the State Historic Preservation Office (SHPO) and Kaua'i County Planning Departments for review, to ensure all information is included and completely presented. The Report will be submitted within 3-4 months following fieldwork.

A final report shall then be produced, incorporating any recommended revisions. If **Cultural Surveys Hawaii** disagrees with recommended revisions, consultation will occur with the SHPO and the County Planning Department to resolve these problems. Consultation will occur with both of these offices before the final report is produced.

J. Report Dissemination

Copies of the final report will be sent to Po'ipulani Development Co., the State Historic Preservation Office, Kaua'i County Planning Department, a depository of the County's choice and the Office of Hawaiian Affairs (OHA).

K. Disposition of Finds and Documentary Data

All materials generated by this project will be deposited for curation at a facility on Kaua'i acceptable to SHPO and Kaua'i County Planning Department.

L. End of Fieldwork Report

An End of Fieldwork Report will be submitted within 2-3 weeks following the conclusion of field excavations to document the adequate recovery of information from the ground. The State archaeologist will be given a tour of excavated sites and preserve barriers. This interim report and site tour will hopefully be sufficient to allow the State (and County) to verify in writing that the information has been recovered and the preserved sites protected sufficiently to permit construction to proceed.

VII. Summary of Recommendations for Preservation and Data Recovery

The following recommendations are made specific to preservation and data recovery in the Po'ipulani project area.

A. Preservation

1. Total preservation of 10 archaeological sites (86, 900, 913, 934, 938, 939, 946, 947, 953 and 966);
2. Continuous fencing and flagging of all preserve sites portions to make them highly visible before ground disturbance begins. These fenced and flagged areas will contain buffer zones of at least 50 feet around the sites;
3. Archaeological monitoring during construction to insure avoidance of preserve areas, advise any incorporation of archaeological sites into the golf course and to respond to unexpected findings;
4. Testing of possible burial sites not listed for preservation. If burials are found these sites will be preserved;
5. Maintain security of preserve areas in all phases of construction and pre-construction to prevent rock robbing and vandalism, to include immediate posting of signs at road access points forbidding unauthorized rock gathering;
6. Preparation of a long-term preservation plan to address

interpretation and treatment of preserved sites. Preserved sites should not be cleared of vegetation until construction is completed;

B. **Data Recovery**

7. Cross section trenches of _'auwai_, agricultural fields, and field walls;
8. Testing of larger habitation sites with more complete excavation of 2;
9. Testing of at least half of all temporary habitation sites with complete excavation of 2-3; In the remaining temporary habitations sites data recovery will consist of further mapping.
10. Testing of 2 cave sites with a one-meter square trench each, to recover chronological and paleontological data;
11. Preparation of an end of fieldwork Report and arrangement of a site tour with SHPO.
12. Preparation of a final report on all data recovery (and monitoring) findings.

References Cited

Hammatt, H. H., W. Folk, and M. Stride
1990 Archaeological Inventory Survey of the Proposed Po'ipulani Golf Course and Residential Development, Kōloa, Kaua'i.

Rosendahl, Paul. H. and A. Walker
1990 Archaeological Data Recovery - Phase II, Hyatt Regency, Kaua'i Mitigation Program, PHRI, Hilo.

Appendix I

Preliminary Archaeology Reconnaissance Report Regarding the Proposed Golf Course and Residential Development Located at Po'ipu, Kaua'i,

by Mr. Joseph Kennedy

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JOSEPH KENNEDY
Archaeologist

Mr. Ray Smith
39 Diablo Rd. Suite 207
Danville, California

February 24, 1990

RE: <u>Preliminary Archaeological Reconnaissance Report Regarding The Proposed Golf Course and Residential Development, TMK: 2-8-14, Located at Poipu Kauai.</u>

Dear Mr. Smith:

At the request of your office, Archaeological Consultants of Hawaii, Inc. has conducted a preliminary reconnaissance survey at the above location. The purpose of this report is to advise the client regarding the presence or absence of cultural materials on the subject property and to make recommendations regarding the future treatment of these sites in order to satisfy county and state permit requirements as outlined in the Hawaii Revised Statutes (HRS) under Chapter 6E.

The subject property is located in the <u>ahupua'a</u> of Koloa in the Kona District of the Island of Kauai. Vegetation on the subject property may be divided into two broad categories - that which is used for pasture and is covered with a variety of weeds and grasses - and a second area, most notably in the southern section of the property, which is covered in a thick growth of <u>haole-koa</u> (<u>Leucaena glauca</u>). There were no permanent water sources noticed on the property.

A check of the archaeological literature at the Department of Land and Natural Resources, Historic Sites Section, indicate that previous archaeological work has taken place on a portion of this property. This work is available under the title <u>Archaeological Survey and Testing of the Proposed Koloa-Poipu Bypass Road, Koloa, Kauai,</u> by Hallett Hammatt.

In this report, we learn of the presence of 47 archaeological sites in a complex located in the southeastern section of the proposed golf course property. Careful mapping of all sites and some limited testing in a select ten of the 47 was undertaken.

Results of these testing efforts indicate 'only sparse evidence of occupation with no apparent cultural stratification.' (Hammatt 1985:i). The report mentions that radioisotope dating material was recovered but the results were not available in the text.

The Hammatt report is not the only one for this area, Sinoto prepared a preliminary report in 1975 entitled Archaeological Reconnaissance Survey of Knudsen Trust Lands at Koloa, Poipu, Kauai which covered a portion of the southern portion of the subject property below the railroad grade. Unfortunately, this short report only informs the reader that many sites exist in the area and that an extensive amount of additional work will be required sometime in the future.

Other reports on the general area by Connolly (1982), Ching (1974), Hammatt (1978), Kikuchi (1963, 1980), Landrum (1984) and others indicate that this portion of the island was well-settled and developed in precontact time.

Our survey of the subject property took place over a three and one half day time period and consisted of a team of four archaeologists making a series of systematic sweeps of the property. One evening was also spent with the owner of the land, Mr. Vladamir Knudsen, in search of informant testimony that may shed some light on several of the features we identified on the property. While Mr. Knudsen was cooperative and cordial, it was quite clear that he was not familiar with some of the features contained on his property, nor the extent of previous archaeological work that has taken place there.

Our survey results may be summarized as follows:

1). A sizeable lave tube opening was noticed in the northern portion of the property. Any exploration of the tube was beyond the scope of this report; however, it was noticed that some midden was scattered near the entrance and that hollow domes are abundant in the immediate area.

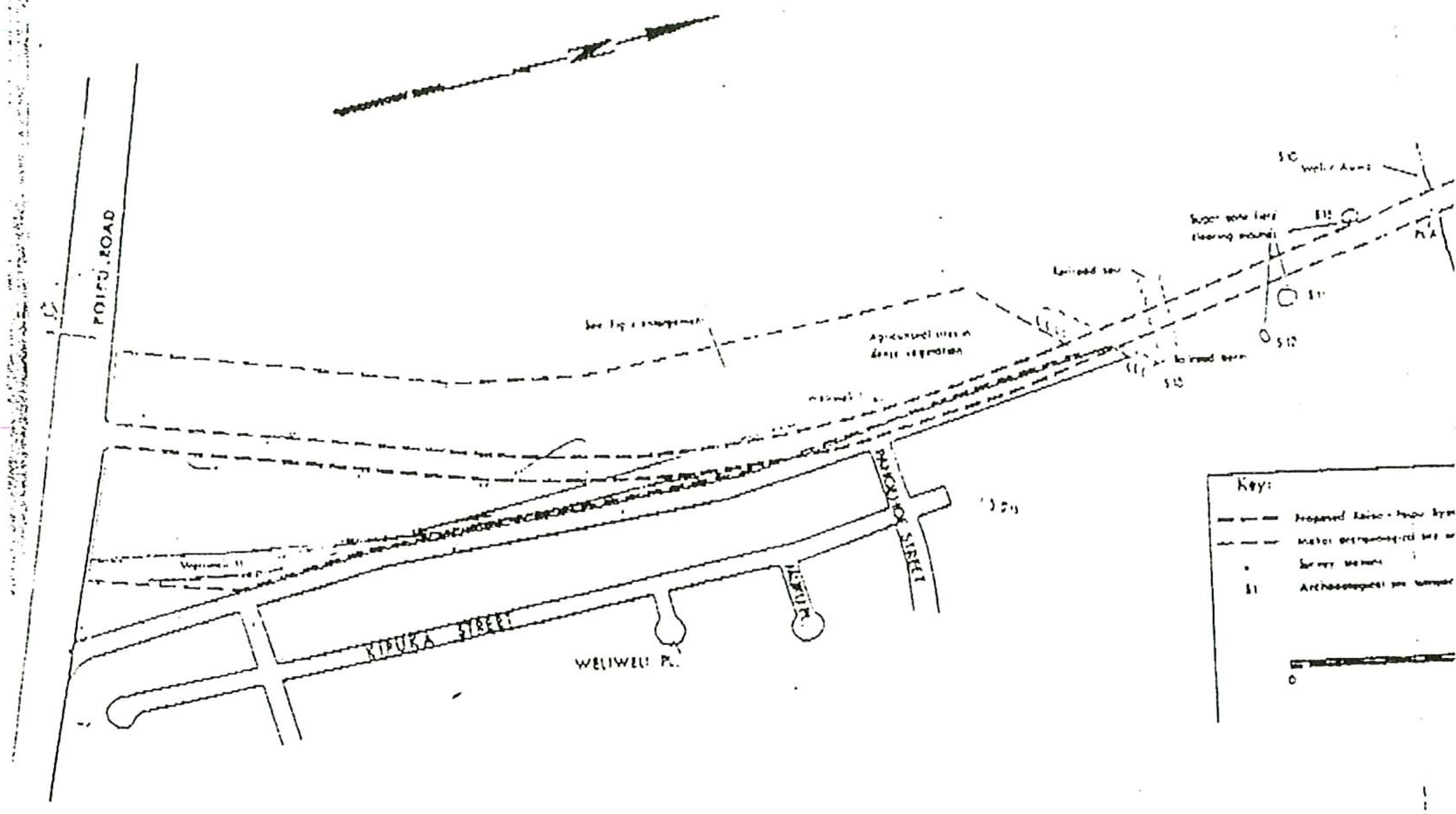
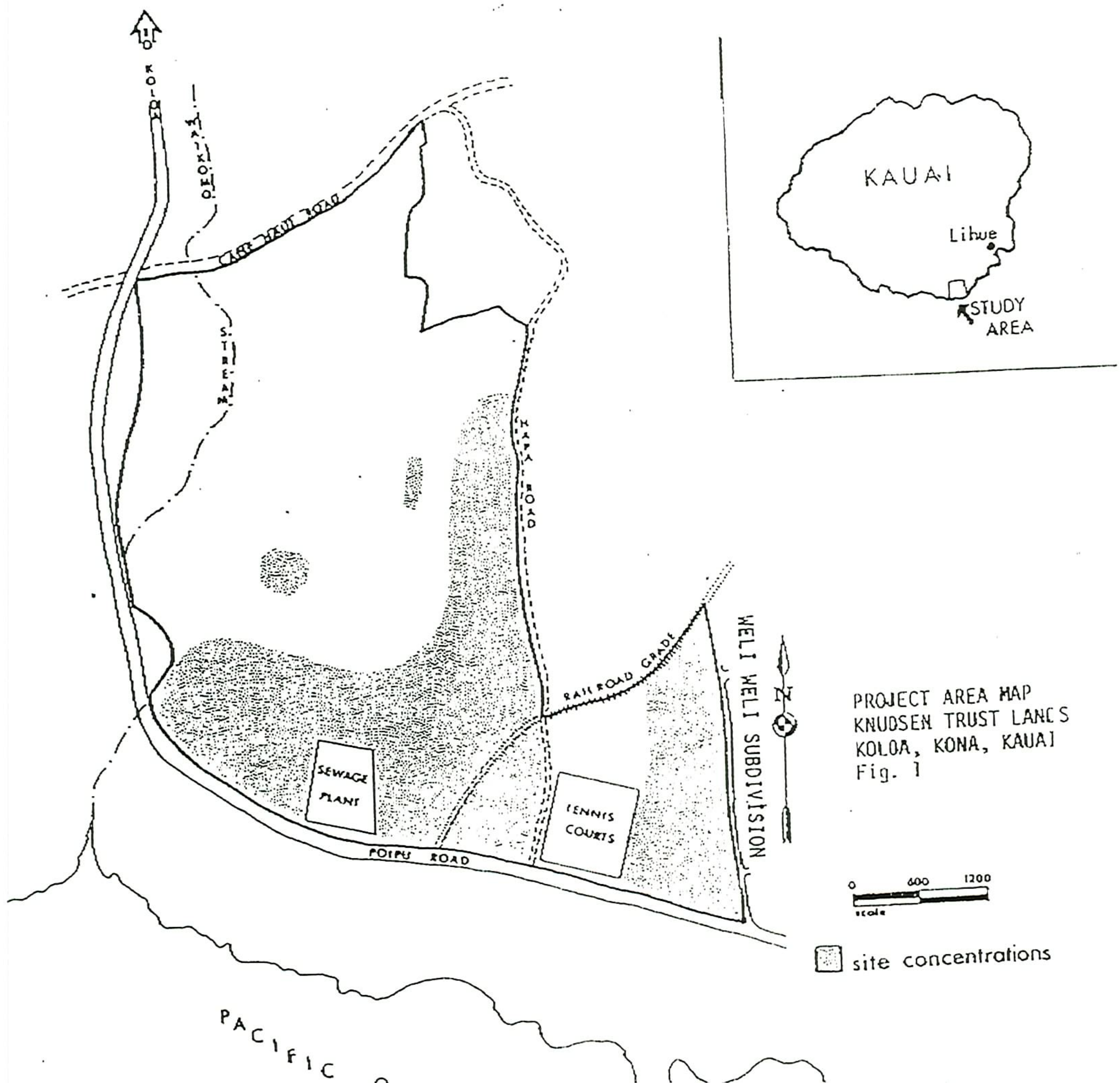


Fig. 3 Proposed Koloa–Poipu Bypass Road Showing Major Archaeological Sites.

From Hammatt 1985



PROJECT AREA MAP
KNUDSEN TRUST LANCS
KOLOA, KONA, KAUAI
Fig. 1

'noto 1975

2). The bed of the old Koloa railroad (long since abandoned) bisects the property in the southern quarter.

3). In the haole-koa thicket along the southern boundary of the property between the western limits of Hammatt's 1985 survey and the western boundary of the subject property there are a number of scattered sites. The majority appear to be agricultural in nature.

4). Throughout the property there are a number of low walls. There can be little doubt that many of these are related to historic ranching activities. At least one wall appears to conform to the <u>ahupua'a</u> political boundary.

5). Along the western boundary are a series of crude rock mounds. Preliminary indications are that these are related to the construction of the power line that runs along the boundary with the Kiahuna property.

CONCLUSIONS AND RECOMMENDATIONS

To begin, the lava tube entrance must be entered and all chambers mapped to term or subject property boundaries. Excavation of the floor should be conducted if possible. The reason for this attention has to do with the possibilities of human burials contained within this tube, a thin lava crust above and the absence of chronological information from surface sites already identified on the property.

Next, the archaeological sites located in the <u>haole-koa</u> thicket between the limits of Hammatt's 1985 survey and the western boundary of the subject property must have their position fixed on an overall map of the property, be sketched to scale, photographed, and test excavated.

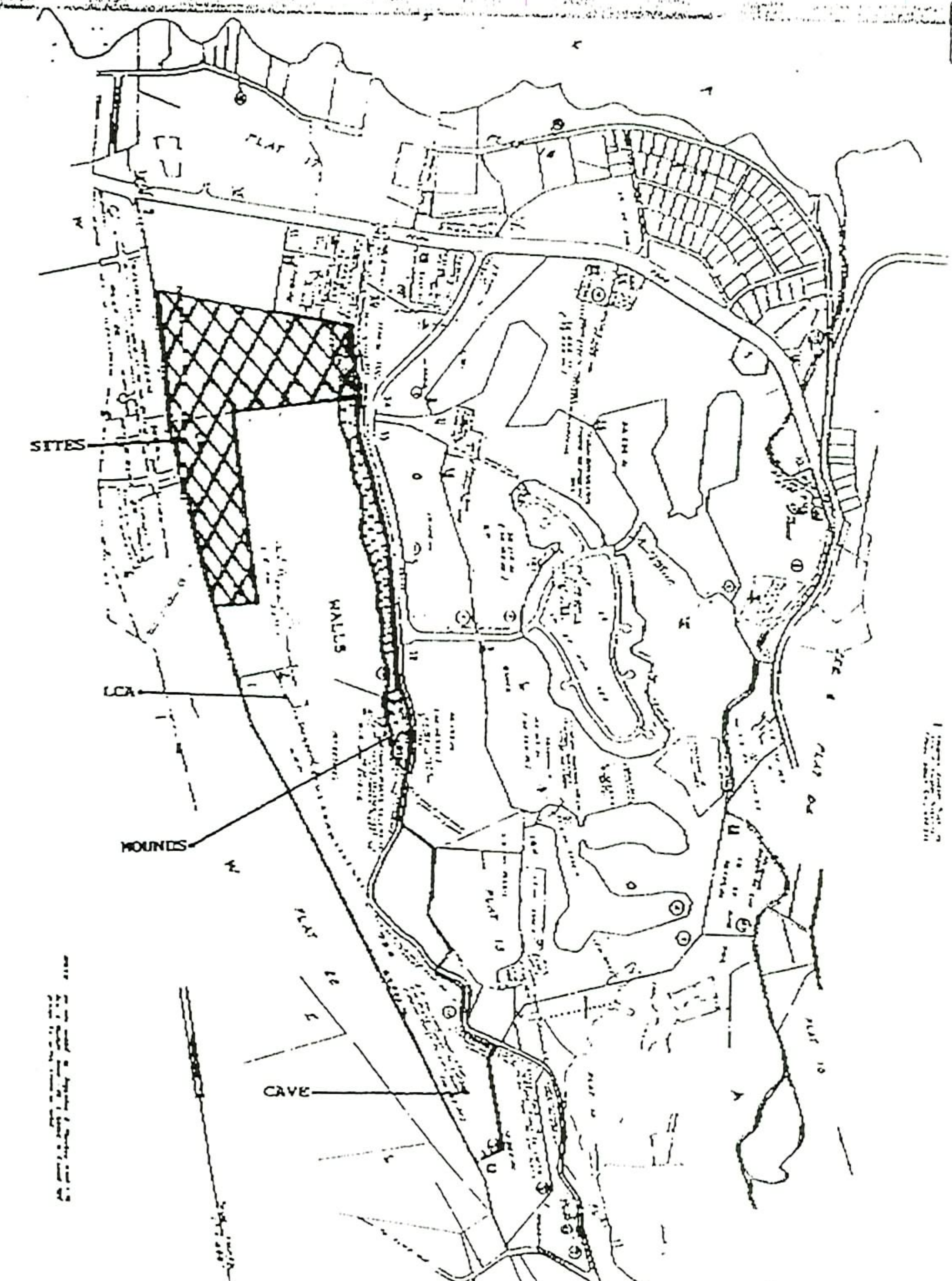
It is our opinion that the abandoned railroad bed will not be an area of archaeological concern; however, we are aware that the ORLC bed, a similar structure on Oahu has been placed on the National Register of Historic Places.

In addition, the walls on the property, regardless if ranching related, need to have their position fixed on a map and the mounds along the western boundary need to have their suspected function collaborated by reliable informant testimony.

If there are any questions regarding this report, please feel free to contact me.

Aloha,

Joseph Kennedy
Consulting Archaeologist



KAUAI TAX MAP KEY 2-8-14

EXHIBIT A

revised 9/12/91

III. Plans for Preservation

A. Introduction

Because of the nature of the development it is possible to preserve a number of archaeological sites from direct development impact. In terms of numbers - of the total of 63 significant sites, nine will be completely preserved and 1 will be partially preserved (Railroad berm Site 947). In addition, the disposition of 6 of the sites is not determined at this time pending archaeological testing to determine if human burials occur within them. If burials are found then these sites will be preserved.

B. Preservation Plans

The following preservation measures will be taken

1. Physical Preservation of all or parts of the most well-preserved agricultural/habitation complexes which best represent former Hawaiian use of the land. These complexes are Sites 913 and 966.
2. Physical Preservation of well-preserved, excellent examples of habitation sites. Included in this category is Site 86, recorded by Bennett in the late 1920s, and Site 900, another habitation platform.
3. Physical Preservation of both lava tube cave sites, Sites 939 and 936, not only because of their archaeological significance but because they almost certainly contain burials. All areas above the tube chambers should be kept as open space.
4. Physical Preservation of all other sites which are likely to

contain burials or which testing shows to contain burials. Site 953 should definitely be preserved. This site will be tested to establish if there is a burial in the rock fill of the platform.

5. Physical Preservation of portions of Site 947, the railroad berm. The berm is best preserved at its western end.

6. Physical Preservation of some of the well-preserved walls. The best examples are found at Sites 934 and 938. These walls are representative of the past use of the land and reflect the unique character of the traditional Kōloa landscape.

7. Physical Preservation of any other sites which can possibly be incorporated into the development landscaping and designated as open space.

C. **Preservation of Burial Sites**

There are 8 sites designated as possible or probable burial sites as mentioned in the Inventory Survey. Three of the probable burial sites (a total of 5) will be preserved. Included in this list is Site 939 which shows exposed human bone and is therefore a confirmed burial site. Also included is Site 953 which is a highly probable monument platform burial. This site will be tested to establish if it is a burial site. Site 926 lava tube is also a probable burial site which will be preserved. The remaining 5 possible burial sites will be tested. If burials are located in them then they will be preserved.

and _lo'i_ later planted in cane. In deeper soil areas trenches will be dug by backhoe.

3. Cross section trenches through field walls, stone terraces and earthen mounds in 3-5 spatially separated localities to recover possible stratigraphic succession of agricultural features.

C. **Habitation Sites**

1. All 4 suspected permanent habitation sites will be tested, with more extensive excavation of two. The selection of the sites for more complete excavation will depend on the results of the testing. The habitation sites with the longest and deepest stratigraphic sequence will be chosen for complete excavation.

2. At least half (approximately 13) of the smaller shelters (C-shape, U-shape, L-shape, etc.) will be tested with complete excavation of 2-3. In the others, data recovery will consist of further mapping. Both isolated shelters in fields as well as those clustered around major habitation sites will be chosen for testing and excavation. These sites will be chosen for testing and excavation on the basis of depth of soil deposits and probability of associated features such as hearths.

D. **Burial Sites**

There are 5 probable burial features (926D, 940, 936) within the Po'ipulani project area not presently on the preserve list. These and Site 953 (a preserve site) will be tested to address research questions and to determine presence or absence of burials and to estimate numbers of individuals. If burials are found the sites will be preserved.

E. Caves

There are two cave sites in the Po'ipulani project area; a small lava tube shelter (939) and a long tube site in the mauka portion of the project area (946). Both of these caves are suspected burial sites and are to be preserved. The entrances will be sealed or closed to allow only authorized access to prevent looting. Data recovery is therefore not necessary. However, brief testing of the cave sediments (a single 1 meter square) will be conducted to collect chronological and paleontological data. Faunal samples will be submitted to Dr. Alan Ziegler for identification.

F. Excavation Methods

The following methods will be used in the excavation of all trenches:

1. screening of all sediments through 1/8 inch mesh screen;
2. recovery of all artifacts and shell and bone midden;
3. recovery of all charcoal both as "in situ" samples and

Appendix H

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING, ROOM 555
601 KAMOKILA BOULEVARD
KAPOLEI, HAWAII 96707

January 26, 2005

Hallett H. Hammatt, Ph.D.
Cultural Surveys Hawaii
P.O. Box 1114
Kailua, HI 96734

LOG NO: 2004.3626
DOC NO: 0412NM07

Dear Dr. Hammatt:

SUBJECT: **Chapter 6E-42 Historic Preservation Review – Archaeological Data Recovery of a Portion Of the Eric A. Knudsen Trust lands, Koloa Ahupua'a, Kona District, Kauai Island (Ryzin and Hammatt, CSH, 2004)**
TMK: (4) 2-8-014: por. 019
Koloa, Kona, Kauai

Thank you for submitting the subject report which we received on November 19, 2004 (Ryzin and Hammatt. *Archaeological Data Recovery of a Portion of the Eric A. Knudsen Trust lands, Koloa Ahupua'a, Kona District, Kauai Island* CSH, ms., 2004).

The archaeological data recovery plan and a preservation plan (Hammatt, 1991) was approved in 1991. Data recovery work included additional mapping and testing at four historic sites: Site No. 50-30-10-908 (temporary habitation); Site No. -909 (temporary habitation); Site No. -969 (agricultural); and Site No. -973 (agricultural). These sites were evaluated as significant under criteria D. Only in Site No. -908 were a limited amount of artifacts, midden and charcoal recovered. The other sites had no cultural material. Three radiocarbon dates were obtained from charcoal samples recovered from Site No. -908. Dates ranged from AD1530- AD1950. The chronological information on the other on-going projects was very interesting.

We can deem the report adequate, and accept it as final. We also recommend that this report also be reviewed by the Kauai Historic Preservation Review Commission.

Should you have any questions, please contact Nancy McMahon, our Kaua`i archaeologist, at 742-7033 on Kaua`i.

Aloha,

Melanie Chinen, Administrator
State Historic Preservation Division

NM:jen

c: Ian Costa, Director, Department of Planning, County of Kauai, 4444 Rice Street, Suite 473, Lihue, HI 96766
Stacey Wong, Eric Knudsen Trust
Chair, Kaua`i Historic Preservation Review Commission

Archaeological Data Recovery
of a Portion of the Eric A. Knudsen Trust Lands
Kōloa Ahupua‘a, Kona District, Island of Kaua‘i

TMK 2-8-14: 19 por.

by

Karl Van Ryzin, B.A.
and
Hallett H. Hammatt, Ph.D.

Prepared for

Eric A. Knudsen Trust

by

Cultural Surveys Hawai‘i, Inc.
November 2004

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I. INTRODUCTION

A. Project Background

At the request of the landowner, the Eric A. Knudsen Trust, Cultural Surveys Hawaiʻi Inc. (CSH) completed a Data Recovery project within the Village at Poʻipū, Phase 1 Project Area at Kōloa Ahupuaʻa, Kona District, Island of Kauaʻi (TMK: 2-8-14:19 por.) (Figures 1-2). The data recovery was for four State Inventory of Historic Properties (SIHP) sites, 50-30-10-908, -909, -969, and -973. A Data Recovery Plan and Preservation Plan (Hammatt 1991) for these sites was prepared for the former Poʻipūlani project, entitled *Data Recovery and Preservation Plan for the Poʻipūlani Development Area*.

The data recovery and preservation plan (Hammatt 1991) was formulated based on the results of an archaeological inventory survey, entitled *Archaeological Inventory Survey of the Proposed Poʻipūlani Golf Course and Residential Development Kōloa, Kauaʻi* (Hammatt, Folk, and Stride 1991). The inventory survey covered 160 acres (TMK 2-8-13 por. 1; 2-8-14 por. 1, 3, 19) of the then proposed Poʻipūlani golf course and residential development project and was completed in July 1991 and accepted by the State Historic Preservation Division (SHPD). During the 1991 inventory survey, 75 sites were recorded, five of which are located within the current project area, known as the "Phase One Project Area". Four of the five sites were recommended for data recovery (Hammatt 1991). The recommended data recovery procedures included further mapping and testing for SIHP sites -908 and -909, and testing for -969 and -973.

The Data Recovery fieldwork was conducted in June and July of 2004 by CSH archaeologists Doug Borthwick B.A., Steve Rohrer B.S., Tracy Tam Sing B.A., and Jonas Madeus B.A. under the general guidance of principal archaeologist Hallett H. Hammatt, Ph.D.

B. Scope of Work

The scope of data recovery included:

1) Archaeological fieldwork based on a data recovery plan as approved by the SHPD. All artifactual and faunal material and features were documented and analyzed. Samples from these excavations were analyzed for chronological information.

2) Research on historic and archaeological background, including a review of historic maps, written records, and Land Commission Award (LCA) documents. This research focused on the specific project area with general background on the *ahupuaʻa* and district and emphasized settlement patterns.

3) Preparation of an archaeological data recovery report, including the following:

    a. A description of research objectives and field methods used;

    b. Description of all findings with selected photographs, plan drawings, and stratigraphic profiles;

c. The results of laboratory analysis of artifacts, faunal and botanical remains, and samples for radiocarbon dating;

d. Historical and archaeological background sections summarizing pre-contact and historic land use as they relate to the archaeological features;

e. Conclusions drawn from the archaeological field research, laboratory analyses, and background research.

C. Project Area Description

The project area is situated on the southern coast of Kaua‘i in the *ahupua‘a* of Kōloa in the district of Kona. It is within 800 m (one-half mile) of the shoreline at an elevation of approximately 30 to 60 feet (9 m to 20 m) above mean sea level. Waikomo Stream, approximately 1.5 km to the northwest, is a perennial stream and is the primary source of surface water in Kōloa.

The land in the vicinity of the project area is formed of the lavas of the Kōloa Volcanic Series that are post-erosional lavas less than 1.5 million years old (Macdonald and Abbott 1974). These Kōloa Series flows form a broad apron of predominantly *pāhoehoe* lava beneath the project area.

The soil mantle in the project area is identified as very rocky Waikomo silty clay. It is present on slopes ranging from two to six percent and having a representative profile comprised of a surface layer of dark grayish brown stony silty clay 14 inches thick, a six inch thick subsoil layer of reddish stony silty clay, and hard rock substratum (Foote et al. 1972).

Rainfall averages between 30 and 40 inches a year (Armstrong 1973); prevailing winds are from the northeast, and temperatures range from approximately 60 to 90 degrees Fahrenheit throughout the year. This dry environment with shallow soil today supports predominantly *koa haole* (*Leucaena glauca)*, exotic grasses, and weeds, though cattle grazing in the project area has kept the vegetation in check.

D. Methods

1. Excavation Methods

The following methods were used in the excavation of all trenches:

1. Screening of all sediments through 1/8 inch mesh screen;
2. Recovery of all artifacts and shell and bone midden;
3. Recovery of all charcoal both as “in-situ” samples and from the screen;
4. Recording of stratigraphy by scale drawing of at least one profile in each one meter square trench;
5. All excavations to culturally sterile soil deposits or bedrock;
6. Sites tested were mapped to scale showing all internal features and excavated trenches.

2. Laboratory Methods and Report Preparation

   This phase of work involved the following:

   1. Identification and cataloging of artifactual material including both historic as well as pre-contact forms. Artifacts were measured with representative samples drawn and/or photographed to scale.
   2. Identification, weighing, and analysis of midden material to genus and species. This information tabulated for each layer within each stratigraphic unit within each site.
   3. Preparation, submittal and dating of datable samples (volcanic glass and charcoal).
   4. Dating and identification of historic era artifacts.
   5. Preparation and submittal of special faunal remains.

3. Report Preparation

   The final report to contain the following:

   1. An in-depth presentation of each research question incorporating prior archaeological and historical studies in the Kōloa area.
   2. Site findings, maps, descriptions, and surface collections for each site will be discussed separately. Site maps, and stratigraphic profiles will be included.
   3. A section on artifact analysis.
   4. A section on midden analysis.
   5. A section on volcanic glass and radiocarbon and historic period artifact chronology.
   6. A summary chapter that re-evaluates the findings on each research question.
   7. References
   8. Appendices

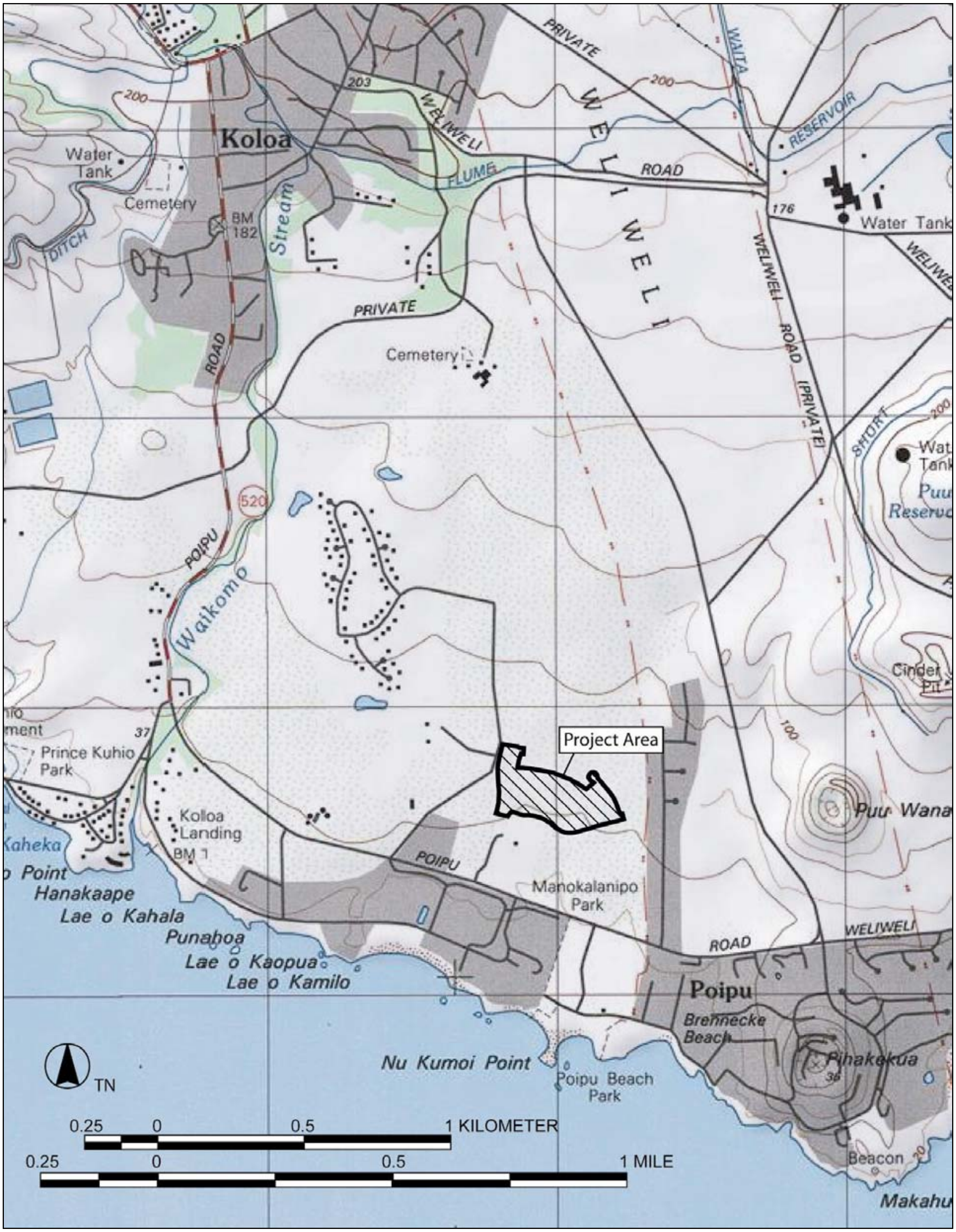

Figure 1. USGS Topographic map showing location of Phase 1 Project Area (hatched area)

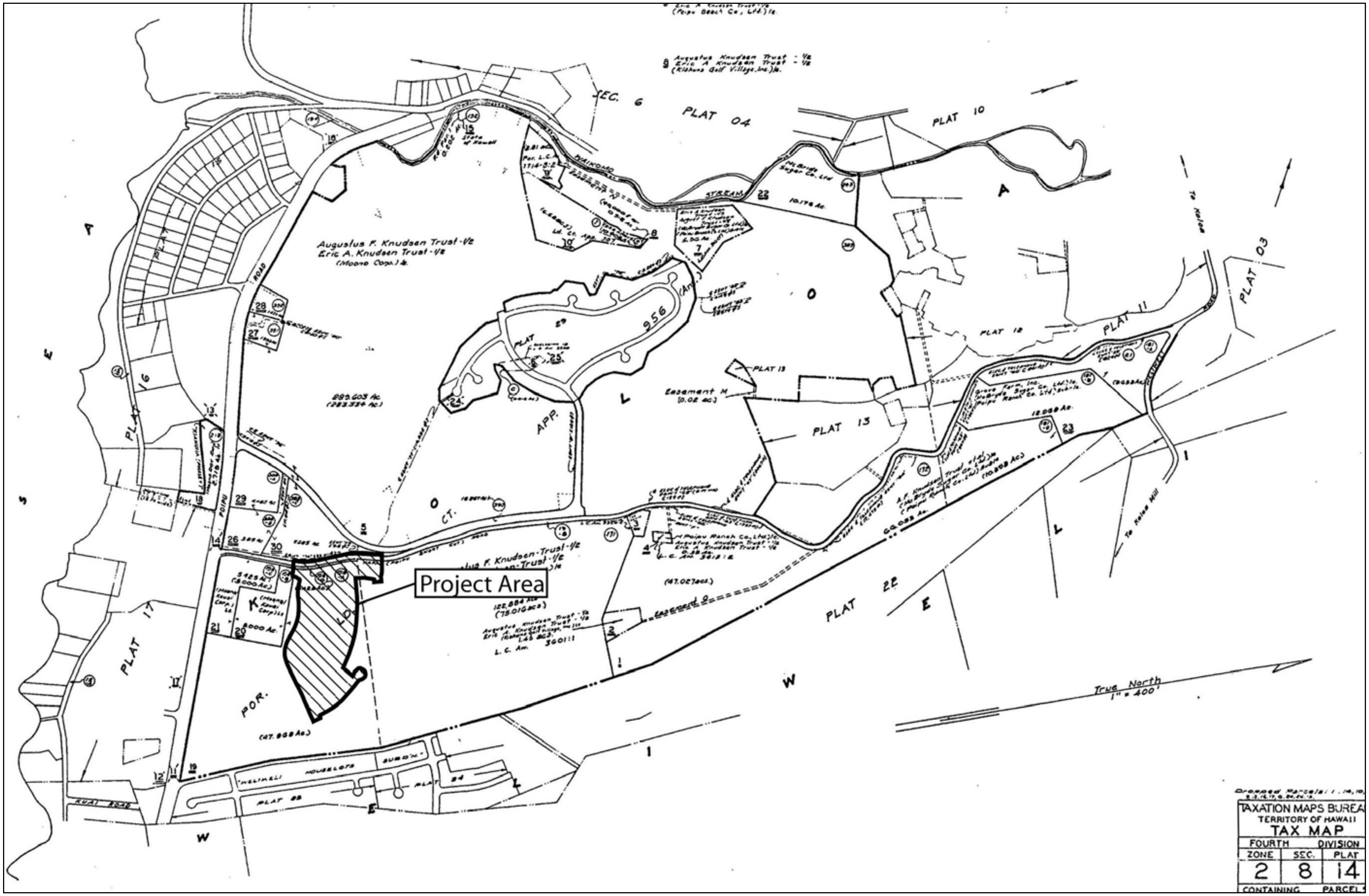

Figure 2. TMK 2-6-04, showing location of the project area (hatched area)

II. HISTORICAL BACKGROUND

A. Historical Setting: Pre-Contact Kōloa

The project area is in the *ahupuaʻa* of Kōloa in the Kona District on the island of Kauaʻi. Few records exist that document traditional Hawaiian life in the *ahupuaʻa* of Kōloa. While settlement by westerners with religious and commercial interests make the area a focus of documentation after the first quarter of the nineteenth century, the accounts generated generally focus on the lives and concerns of the westerners themselves with only anecdotal references to the Hawaiian population. Two nineteenth century documents (Boundary Commission Testimony of 1874 and a Lahainaluna manuscript of 1885), however, did provide two Hawaiians an opportunity to speak for themselves and thus offer a possible insight into the life of Kōloa before the arrival of westerners.

A dispute over the northern boundary of Kōloa Ahupuaʻa in 1874 led to a hearing before Duncan McBryde, the Commissioner of Boundaries for Kauaʻi. One native witness, Nao (who describes himself as born in Kōloa but presently living in Haʻikū), in order to show that Hoaea (the area in dispute) was indeed at the northern boundary of Kōloa, testifies: "At Hoaea tea [sic] leaves were hung up to show that there were battles going on" (Boundary Commission, Kauaʻi, vol. 1, 1874:124). That there was a traditional "warning system" well known to all natives suggests that Kōloa, throughout its history, may well have been the scene of some serious conflicts, serious enough and perhaps often enough to warrant devising such a system.

Additional evidence of a rich history within Kōloa is offered in a Lahainaluna document produced eleven years later. This document appears to be based on an oral historical project. On September 7, 1885 a student from Lahainaluna Schools (HMS 43 #17) interviewed Makea, "a native who is well acquainted with Kōloa," and recorded "what she said about the well-known places in the olden times." More than sixty-four years after the abolition of the *kapu* system and almost as many years of contact with westerners, Makea was able to describe in detail fourteen *heiau* within the Kōloa area. For example:

> Maulili was the first heiau of south Kōloa. Kapulauki was the first chief of Kōloa, Kiha came next. That is the chief I know of. He was a ruling chief of Kauaʻi in the olden days, when the heiau was standing there. It had already been built and men had been sacrificed on its altars. This Kiha was called Kiha-of-the-luxuriant-hair. Another name for him was Kakae and another was Ka-pueo-maka-walu (Right-eyed-owl).
>
> This heiau was also famous for this reason -- it was the first heiau to which Kawelo was carried after he had swooned in Wahiawa, in the battle where stones were used as missiles.
>
> The location of this heiau was not known, but a deaf mute knew and it was he who pointed it out to the chiefs, and that is how it was rediscovered in the olden days.

> Kiha lived on the eastern side of the heiau and Aikanaka lived on the northeastern side. This chief, Aikanaka, was the one with whom Kawelo fought and he was the owner of this heiau at that time.

B. Mythological and Traditional Accounts

Clearly Kōloa was a particularly important *ahupuaʻa* in traditional Hawaiian times. At least fourteen *heiau* of varying sizes and functions have been documented in the Kōloa area (Thrum 1907, Bennett 1931). The presence of the *heiau* and their association with legendary-historic figures such as Kawelo and Aikanaka suggests a heightened cultural richness of the *ahupuaʻa*.

Further confirmation of a rich traditional life within Kōloa is furnished by the presence of a *hōlua* slide on the slopes of Puʻu o Hewa in the *mauka* reaches of the *ahupuaʻa* and by the myriad legends attached to Maulili Pool, a sacred place once located in the present Kōloa Town. J. K. Farley (1907) describes the pool and its legendary associations:

> The pool of Maulili, on Waikomo stream...is a few hundred feet south of the Maulili road bridge. The gods Kāne, and his brother, Kanaloa, are said to have once slept above it, on its eastern bank and left the impress of their forms as can be seen in the apapa...The apapa in this vicinity is called an Unu. and a Heiau, but was never walled in, it is said. [This heiau may be the Maulili Heiau described by Makea above.] On the nights of Kāne the drums are heard to beat there, also at the sacred rocks, or unu's, of Opuokahaku and Kānemilohae, near the beach of Poʻipū...
>
> In the Maulili pool lived a large Moʻo, named 'Kihawahine'...The eastern wall of the pool, just below the resting places of Kāne and Kanaloa, for a short distance, only, is called the 'Pali of Kōloa.' The District of Kōloa is named for this Pali, we are told by old Hawaiians. To the south of the Pali o Kōloa, in the wall is a rock named 'Waihanau'...as one of their meles has it:
>
> "*Aloha wale ka Pali o Kōloa,*
> *Ke Ala huli i Waihānau e, hānau.*"
>
> To the south of Waihānau is a projecting rock named 'Ke elelo o ka Hawaiʻi' -- the tongue of Hawaiʻi, said to have been wrested and brought from Hawaiʻi by the Kauaʻi warrior Kawelo, of Wailua.
>
> At the southern end of the Maulili pool started two large 'auwai's, that watered the land east and west of Kōloa [Farley 1907:93].

Thus, this sacred legend-imbued locus was the source that gave life to the lowland taro patches of Kōloa. These special associations would not have been lost on the Hawaiians dependent upon those waters. While taro would have been essential to the life of the *ahupuaʻa*, other resources were available. Bernice Judd, writing in 1935, summarizes most of what was known at that time of the traditional Hawaiian life of Kōloa:

> In the old days two large ‘auwai or ditches left the southern end of the Maulili pool to supply the taro patches to the east and west. On the kuaunas or embankments the natives grew bananas and sugar cane for convenience in irrigating. Along the coast they had fish ponds and salt pans, ruins of which are still to be seen. Their dry land farming was done on the kula, where they raised sweet potatoes, of which both the tubers and the leaves were good to eat. The Hawaiians planted pia (arrowroot) as well as wauke (mulberry) in patches in the hills wherever they would grow naturally with but little cultivation. In the uplands they also gathered the leaves of the hala for mats and the nuts of the kukui for light [Judd 1935:53].

It appears that the relatively good situation for the development of irrigated agriculture (the Kōloa Field System) focused agriculture and habitation at elevations well below the present project area. As the Judd account given above asserts, it is likely environs like the present project area were used for less intensive cultivation of patches of sweet potato, *pia*, and *wauke* and the gathering of *hala*, *kukui* and other upland resources.

C. Early Historic Period

Accounts by visitors and settlers at Kōloa Ahupua‘a focus on these westerners’ own concerns--religious and commercial--as these concerns appropriate the historical record of Kōloa in the 1800s. However, scattered throughout the accounts are occasional references to the Hawaiians of the *ahupua’a,* which may give some insights into their lives.

In his journal, Gorham Gilman describes a visit to Kōloa in 1845 when he explored “some natural caves near the sea side.” What he saw in one cave was only the most recent version of a scene that must have taken place there over countless generations:

> …looking round I saw a large hole in the ground near me, into which we descended by a pile of stones raised from the bottom for that purpose…here a strange site met our view, there were some dozen or more natives seated around, some preparing a pig for the fire, others curing their tobacco & all engaged…and making the place a natural kitchen (Gilman n. d.:11).

While the use of caves for habitation is of course known throughout the Hawaiian Islands, Gilman’s account suggests an especially useful adaptation by the Hawaiians of Kōloa of a fortuitously large and accessible cave site to their specific needs. Those needs may have included health concerns as well. Charles Wilkes (1848), who visited Kōloa in 1840, noted: “There are no epidemics; asthma and ophthalmia are the diseases most prevalent: the latter is ascribed to the strong winds which blow constantly, and irritate the eye with the minute particles borne on them.” The easily accessible caves of the *makai*-ward regions of Kōloa, G. W. Bates (1854), probably describing the same cave visited by Gilman, noted its use as an infirmary. “This cave has been applied to a variety of purposes. It has been used as a hiding-place in time of war. When a recent epidemic swept over the group, it was used as a hospital for the sick and dying” (Bates 1854: 158-159).

The American Board of Commissioners for Foreign Missions (ABCFM) missionary Samuel Whitney described, in an article in the *Missionary Herald* (June 1827:12), a visit to Kōloa with Kaikio‘ewa, the governor of Kaua‘i, in 1826:

> The people of this place were collected in front of the house where the old chief lodged in order to hear his instructions. After a ceremony of shaking hands with men, women, and children they retired...
>
> Our company consisted of more than a hundred persons of all ranks. The wife of the chief, with her train of female attendants, went before. The governor, seated on a large white mule with a Spaniard to lead him, and myself by his side, followed next. A large company of aipupu, [*ʻāʻīpuʻupuʻu*] cooks, attendants came on in the rear [p. 284].

Whitney's account suggests something of the deference paid to the *aliʻi* by the local populations and the scale at which the *aliʻi* carried out their functions. An even grander view of that deference is provided in an account of a later visit by an *aliʻi* to Kōloa. John Townsend, a naturalist staying in Kōloa in 1834, described a visit by Kamehameha III:

> In the afternoon, the natives from all parts of the island began to flock to the king's temporary residence. The petty chiefs, and head men of the villages, were mounted upon all sorts of horses from the high-headed and high-mettled California steed, to the shaggy and diminutive poney [sic] raised on their natives hills; men, women, and children were running on foot, laden with pigs, calabashes of Poe [sic], and every production of the soil; and though last certainly not least, in the evening there came the troops of the island, with fife and drum, and 'tinkling cymbal' to form a body guard for his majesty, the king. Little houses were put up all around the vicinity, and thatched in an incredibly short space of time, and when Mr. Nuttall, and myself visited the royal mansion, after nightfall, we found the whole neighborhood metamorphosed; a beautiful little village had sprung up as by magic, and the retired studio of the naturalists had been transformed into a royal banquet hall... [In Palama and Stauder 1973:18]

On December 31, 1834, Peter Gulick and his family arrived in Kōloa. Apparently the first foreigners to settle in the *ahupuaʻa*, they initiated the process of rapid change that would re-shape the life of Kōloa in the nineteenth century. In 1835, a 30 by 60 foot grass house was erected as a meetinghouse and school (probably located at Kōloa Town). Mr. Gulick initiated sugar cane cultivation and collected a cattle herd for the Protestant Mission. In 1837 a 45 by 90 foot adobe church was built (probably at the same ABCFM site) and the first mission doctor, Thomas Lafon, arrived to assist Mr. Gulick (Damon 1931:179, 187). The Kōloa mission station apparently flourished immediately. Charles Wilkes, a member of the U.S. Exploring Expedition visiting Kōloa in 1840, recorded:

> The population in 1840, was one thousand three hundred and forty-eight. There is a church with one hundred and twenty-six members, but no schools. The teachers set apart for this service were employed by the chiefs, who frequently make use of them to keep their accounts, gather in their taxes, etc. The population is here again increasing partly by immigration, whence it was difficult to ascertain its ratio [Wilkes 1845:64].

Other sources, however, give different population figures for Kōloa during the first half of the nineteenth century. In 1834, according to a report by missionaries on Kauaʻi, the inhabitants of the *ahupuaʻa* numbered 2,166. An article in the *Pacific Commercial Advertiser* of December

21, 1867 estimated that the population in 1838 was about 3,000 (though, by 1867, it had been reduced to a third of that number). James Jackson Jarves, who visited Kōloa and Kaua‘i for nine months during the early 1840s, recorded:

> Kōloa is now a flourishing village. A number of neat cottages, prettily situated amid shrubbery have sprung up, within two years past. The population of the place, also, has been constantly increasing, by emigration from other parts of the island. It numbers, now, about two thousand people, including many foreigners, among whom are stationed a missionary preacher, and physician, with their families [Jarves 1844:100].

The arrival of “many foreigners” was the cause of, and the native immigration to Kōloa was the result of, the many commercial activities that burgeoned beginning in the 1830s. In 1835 Ladd and Company gained from the king and local chiefs the lease of about one thousand acres at Kōloa for 50 years at $300 a year and “allowed the use of the waterfall and an adjoining mill site at Maulili pool, not far from the thousand acres, together with the right to build roads, the privilege of unrestricted buying and selling and freedom from local harbor dues” (Judd 1935:57). Ladd and Company was not the first to mill sugar cane in the area: there was a Chinese-operated granite roller mill in operation at Māhā‘ulepū, Kōloa, in 1830; it was, however, the first plantation-organized industry in Hawai‘i (Damon 1931:176, 198). Judd notes the following:

> The company was permitted to hire natives to work on the plantation provided they paid Kauikeaouli, the king, and Kaikio‘ewa, the governor of Kaua‘i, a tax for each man employed and paid the men satisfactory wages. The workers were to be exempt from all taxation except the tax paid by their employers [Judd 1935:57].

Judd further described the revolutionary implication of this arrangement: “The significance of Ladd & Co.’s lease lay in the fact that it was the first public admission by the Hawaiian chiefs that their subjects had rights of personal property backed with a guaranty of protection to that property” (Judd 1935:58). Local chiefs, fearful of an usurpation of their power, resisted the company’s first efforts to recruit workers, forcing the king’s intervention.

Another missionary, Dr. James W. Smith, who was stationed at Kōloa for forty-five years, beginning in 1842, mentioned in his journal a visit to “the school at Kukui‘ula.” If there was a second school in Kōloa outside the population center of Kōloa Town, Kukui‘ula may have warranted the placing of a school there because of a sufficiently large population in the area.

A long-known history of severe flooding in the central flood plain of Kōloa provided an impetus for the native Hawaiians to develop an irrigated field network well off that plain. In a typical Hawaiian valley such as Pō‘ele‘ele it is difficult to get off the flood plain and in Kōloa a large percentage of homes and agricultural fields are located in the large volcanic terrace *makai* of the project area that is not susceptible to flooding. Thus the extensive *lo‘i* network within the *makai* portion of Kōloa may have been, in part, a clearly thought-out use of a fortuitous land configuration to avoid the force of occasional floods that might, elsewhere on the island, have had disastrous effects. The project area was better suited for forest cultivations and gathering of upland resources.

D. Mid-1800s (Land Commission Awards)

The Māhele records of Kōloa give a picture of what had evolved by the middle of the nineteenth century when Kōloa Ahupuaʻa, consisting of 8,620 acres, was awarded to Moses Kekūāiwa, the brother of Alexander Liholiho (Kamehameha IV), Lot Kapuāiwa (Kamehameha V), and Victoria Kamāmalu. The awarding of the *ahupuaʻa* to Kekūāiwa, through Land Commission Award (LCA) 7714-B, was an outcome of an event twenty-five years in the past: the crushing-by forces loyal to Kamehameha II-of the 1824 revolt on Kauaʻi when Kauaʻi lands were divided up among the chiefs of the other islands.

Eighty-eight other *kuleana* awards were given to individuals within Kōloa Ahupuaʻa. The majority of these LCAs were located in or around Kōloa Town. This concentration of awards around the town area may reflect both the traditional settlement pattern, a focus on the resources of Maulili Pool and Waikomo Stream (a permanent stream), and the movement of the populace to the plantation and missionary centers.

No LCAs fall within the present project area. However, *makai* (south) of the project area are numerous awards, the closest of which is LCA 3286 *Āpana* 1. LCA 3268 *Āpana* 1 was comprised of three *lo*ʻ*i* that were awarded to Walewale. An 1891 map by M.D. Monsarrat shows the location of these awards (Figure 3).

E. Late 1800s To Present

Kōloa became the scene of the confrontation of the traditional social structure with commercially-impelled forces of change. Thus, as the cane growing activity of Ladd and Company developed in the Kōloa area, the presence of this socially convulsive activity within the *ahupuaʻa* would inevitably affect the lives of the inhabitants of the rest of the *ahupuaʻa*. Traditional settlement patterns (e.g. permanent and temporary habitation interspersed throughout the irrigated agricultural fields near the coastal zone and traditional farming along streams) would have been distorted by a shift to Kōloa Town where sugar cane milling activities were located, and a shift to cash crops other than taro.

Although Ladd and Company would go bankrupt in 1845; its earlier success was an impetus for other entrepreneurial attempts within Kōloa. Silkworm farming, oil extraction from *kukui* nuts, cigar manufacturing, sago raising, rice cultivation, and tapioca manufacturing were all attempted with varied success during the middle third of the nineteenth century.

Everyone in Kōloa had to have been affected by the growing activities, associated with the commercial enterprise mentioned above and with the whaling industry, at the nearby Kōloa Landing. Accounts of visitors suggest that the inhabitants of Kōloa, especially along Waikomo Stream, Poʻeleʻele Stream being a major tributary, taking advantage of their nearness to the landing, participated in the booming trade of the port. The naturalist James Townsend, already mentioned above, described the terrain between the landing and Kōloa Town in 1835: "there is a good road made by the natives over a gentle ascent of about two miles, on each side of which taro patches, yam and maize (probably sugar cane) fields abound." The project area, well *mauka* of town, was already the focus of sugar growing while the *makai* lands would thus have been a source of portion of the "10,000 barrels of sweet potatoes…cultivated annually" (Townsend 1839:12).

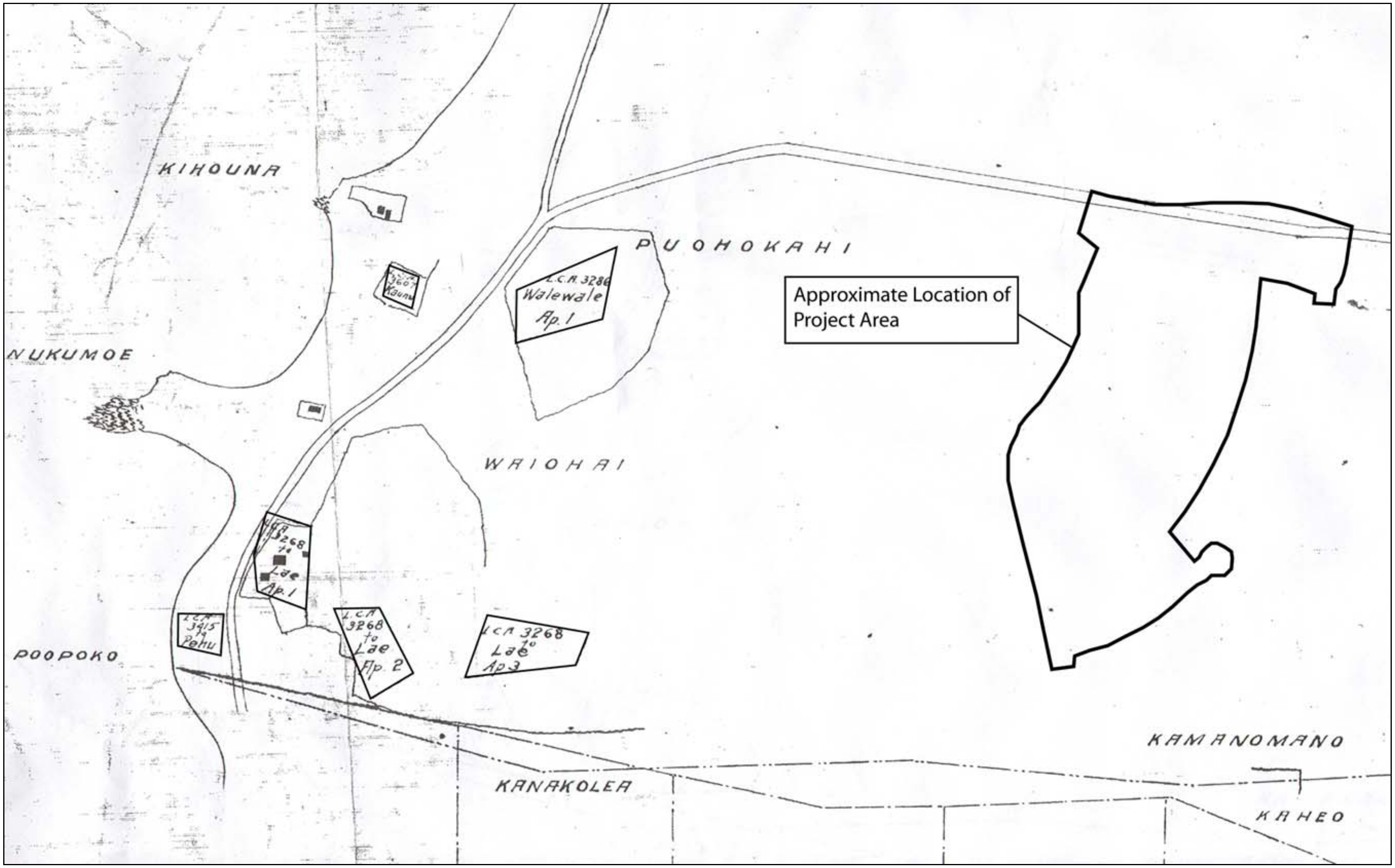

Figure 3. Portion of M.D. Monsarrat (1891) Map (R.M.1694) showing approximate location of project area and location of LCA awards

An article in the *Pacific Commercial Advertiser* of February 19, 1857 described the salient characteristics of the port at mid-century:

> The anchorage is an open roadstead, the tradewind blowing along and a little off shore. During the prevalence of trade it is safe for ships to anchor, but they rarely do so, preferring to procure their supplies 'lying off and on'. The anchorage for schooners is close to shore, in four to six fathoms of water, where it is somewhat sheltered from the wind by a bluff. Owing to the force of the swell and the suddenness which the south wind sweeps around the head lands of the island, and the want of property buoys, a number of coasting vessels have been wrecked of late years in this port. For the trade of the port there is a small rude pier constructed which might be improved at no greater outlay of labor. From the landing there is a good carriage road to the town, distant about two miles. Large quantities of firewood, bullocks and sweet potatoes are furnished to whalers in this port, and these chattels can no where be procured cheaper or better. It is estimated that 10,000 barrels of sweet potatoes are cultivated annually here, which are thought to be the best on the islands. Nearly all the potatoes furnished for the California market are produced here…Sweet potatoes, sugar and molasses constitute the chief trade of the port.

Kōloa became the official port of entry for Kaua'i in the 1850s and participated in the profitable trade with the whaling industry whose peak years ran from the 1830s to the 1860s. A notice in The Friend of June 15, 1847 notes the total haul of three whalers: "Touched at Kōloa, Kaua'i, May 20, [1847] American whale ships *Richmond*, *Winters*, *Coldspring*, 9 months, 550 whales, 150 sperm. Last, from Hobart Town, has on board a runaway…" The records of the Collector General of Customs at Kōloa document the exuberant trade in provisioning and produce shipping at the port. Table 1 lists typical entries from the last months of 1855.

Table 1. Examples of Trade in Provisioning and Produce at Kōloa, 1855

Date	Ship	Potatoes	Fruits	Livestock	Other
Aug. 11	Schooner Welemantic	400 Barrels potatoes	40 bunches bananas	2 pigs	
Sept. 18	Schooner Gen. Morgan	740 Barrels potatoes	20 bunches bananas, 400 oranges	2 hogs, 10 fowls, 1 goat	12 Ib. butter 1 ½ cord wood
Oct. 25	Whaleship Scotland	3 barrels sweet potatoes	100 oranges	2 fowls	6 cord wood
Nov. 7	Schooner Forward	400 barrels. Sweet Potatoes	3 bunches bananas 200 oranges	2 pigs	1 cord wood 3 doz. eggs

Sugar cane cultivation was initiated on a large scale throughout much of Kōloa. A Monsarrat map from 1891 shows sugar cane just *mauka* of Kukuiʻula Bay, as the majority of Kukuiʻula was still not in plantation-type cane cultivation. This changed in the late 1890s with the advent of McBryde Sugar Company which planted most of the lands *makai* of Kōloa town in cane—probably using some of the existing ʻ*auwai* system. E.S.C. Handy noted that the pre-existing taro terraces of Kōloa were "not used for taro, because the water is taken by the sugar plantation" (Handy 1972:428).

Expansion of cane fields and rail lines in the Kōloa area was rapid during the 1890s and by 1903 rail lines had been completed across Kukuiʻula to Kōloa Landing (Figure 4). The manager's report of 1904 states: "Our permanent railroad had been graded into Kōloa Village…A span has also been run down from the main track to the coral sand beach between Kukuiʻula and Kōloa landing, so that we are able to load sand as required for fertilizer and other uses…" (in Conde and Best, 1973:191).

Kōloa Landing was phased out around 1925 when McBryde Sugar Company and Kōloa Sugar Company began using Port Allen. Soon after, McBryde ceased to use the *makai* Kōloa fields. Much of the present study area remained under sugar cane cultivation until the 1990s when these cane lands were converted into pasture.

F. Summary of Historical Background

Although much of the seaward portion of Kōloa is a relatively dry area with approximately 30 inches of rain per year, the perennially flowing streams provided a resource for the development of a rather expansive agricultural system. Accounts of the early history of Kōloa (Farley, 1907; Jarves, 1844; Townsend, 1839; and Judd, 1935) describe in the lands *mauka* of Kōloa Town a seemingly continuous, well-maintained, agricultural complex of taro, yams, sweet potato, and sugar cane that was irrigated by an extensive *ʻauwai* system siphoned off of Waikomo and Pōʻeleʻele streams. This system had a significant influence on later commercial endeavors in Kōloa.

Kōloa is the site of the first organized sugar plantation in Hawaiʻi. Ladd and Company leased about a thousand acres for the sole purpose of growing sugar cane (Palama and Stauder 1973:18, from Judd, 1935). The commercialization of sugar cane in Kōloa had widespread social effects. The traditional view of the *ʻāina* being a responsibility of the *aliʻi* was being transformed.

Kōloa Town, and Kōloa Landing, at the mouth of Waikomo Stream, became prominent commercial centers during the mid to late 1800s, exporting a variety of products such as sweet potatoes, sugar and molasses. Whalers also stopped for provisions of squash, salt, salt beef, pigs, and cattle (Palama and Stauder 1973:20). This heightened activity dramatically altered the social structure and landscape of Kōloa.

Kōloa soon reflected the effects of a traditional social structure in conflict with commercially-impelled forces of change. Traditional settlement patterns would have been significantly changed by a flux to Kōloa Town where sugar cane milling activities were located. Later land use in the study area (i.e. sugar cane, pasture, and macadamia nut farm development) also had detrimental impacts on any surviving traditional structures.

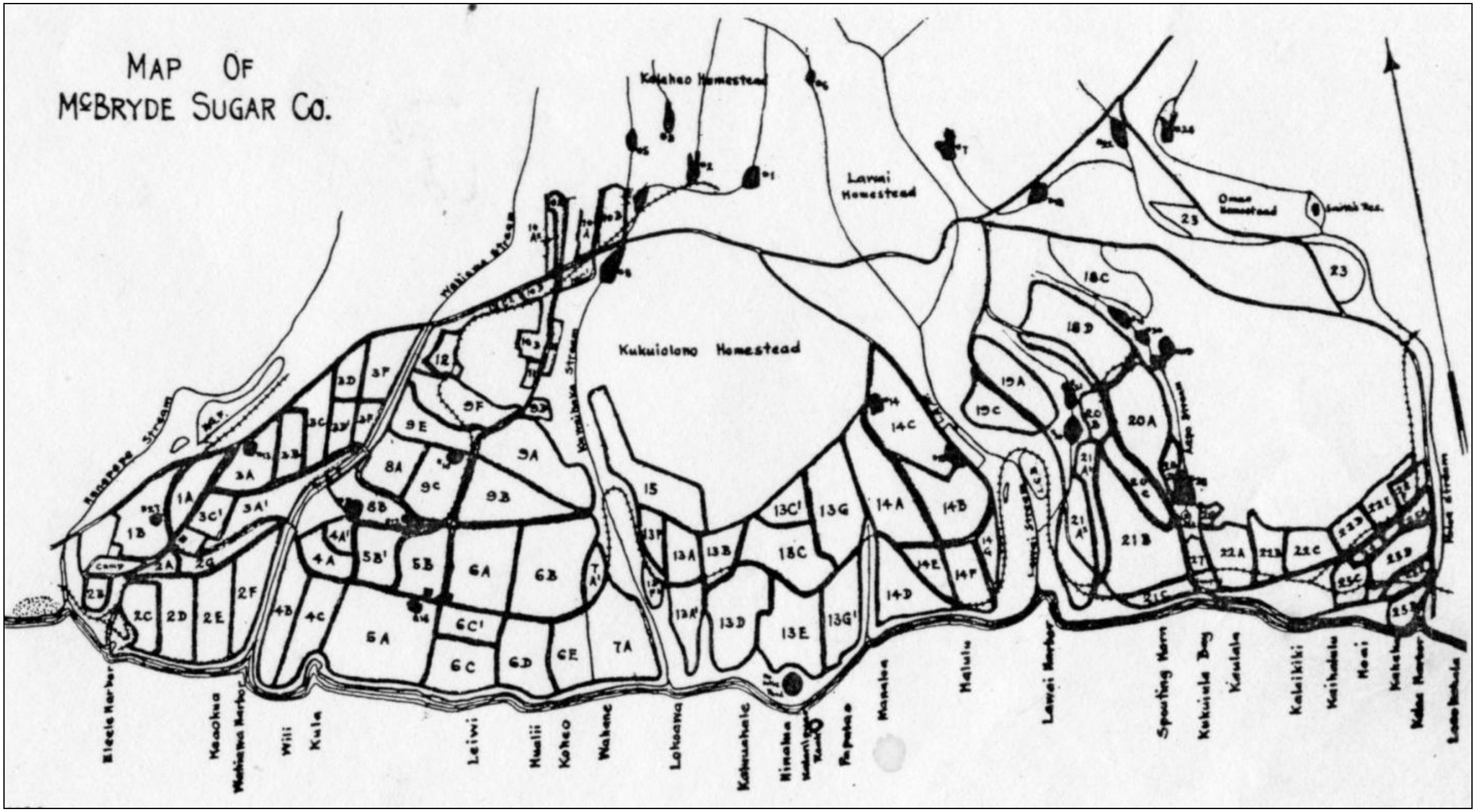

Figure 4. 1923 McBryde Sugar Company Map Showing Numbered Fields and Plantation Rail Lines within Kōloa (from Conde and Best 1973)

III. PREVIOUS ARCHAEOLOGICAL RESEARCH

A. Early Surveys of Major Sites in Kōloa

Archaeological research before 1960 was limited to oral history accounts and surveys of the larger more important sites, especially *heiau* sites along the coast. The first survey of an inventory nature of Kōloa resulted in a catalog of features for the general Kōloa region. This is a listing of temples and shrines (Lahainaluna Schools 1885). The most important is Maʻulili Heʻiau in Kōloa.

> The first heiau of southern Kōloa. Kapulauki was the first chief of Kōloa, Kiha came next. This Kiha was called Kiha of the luxuriant hair (Kiha-ke-oho-lupalupa). Another name for him was Kakaʻe and another was Ka-pueo-maka-walu. Men were sacrificed on it. The heiau was famous because Kawelo was laid on its altar. Kiha lived on the eastern side of the heiau, and Aikanaka on the northeastern side.
>
> There are three areas in Kōloa named Maulili. One is along the coast and is called Maulili-kai. One is inland within the project area. The third is in the town of Kōloa (Kikuchi 1963:84).

Other religious structures described in the Lahainaluna survey include:

> Kue-manu Hieau: It was located at Kualu in Kōloa. Kualu was the chiefess who built it, but any story pertaining to this heiau is not remembered. Human sacrifices were offered there. There was heiau at Wailua similar to this one so it was thought the same chiefess built that one too.
>
> Manini Heiau: Manini was another heiau of Kōloa. It stood near the beach. The heiau was for the gods of the sea, that is Kuhaimoana and others. On the nights of Kane these fish-gods came up to the beach. Their spirits took possession of their keepers, then these men went into the heiau to drink awa. The people were accustomed to doing this in the olden days. On each night of Kane in every month, the drum was beaten to proclaim a kapu on the beach. Men were not allowed to go to the beach at night lest they step on the fish (gods).
>
> Kuhahapo Heiau: Kuhahapo was another heiau. It was Located on the cape of Kahala in southern Kōloa. Hogs and red fish were offered there. The chief who built it is not known.
>
> Louma Heiau: Louma was another heiau, which also stood in southern Kōloa on the mountain side of Ho ʻo-leina-ka-puaʻa (place-to-throw-in-the-pig), a pond on the mountain ward side of the houses. The heiau was close by. Kiha was the chief to whom it belonged. It was a small heiau in which hogs, red fish, etc. were offered.
>
> Lonoikaoualii was the chief and Wakea was the priest who brought the stones from Oahu.

Hale-oio Heiau: Haleoio was another heiau. It was also in southern Kōloa, on the beach . The thing for which this heiau is noted was that when schools of Weweo (a red fish) went to Kahaoi, they also came to this place.

Kaulia Heiau: Kaulia was another heiau. It was very close to the eastern side of Kamohoalii's taro patch, because the heiau was also his. It was a heiau in which to offer hogs and red fish, for the relief of physical ailments. That was the only thing done in this heiau.

Mauna-pohaku Heiau: Maunapohaku was another heiau. It stood on Nahinu's property in southern Kōloa. The name of the chief who built it and that of the priests who officiated there is not remembered.

Ka-iʻa-iki Heiau: Kaiaiki was another heiau that stood on the mountain ward side of the road Leading down to the wharf at the landing. It was on the eastern side in southern Kōloa.

Kuhahape Heiau: Kuhahape was another heiau which was located by a sea pool on the beach of Kōloa.

Halau-a-ka-lena Heiau (Site 50-30-10-3074): The heiau now completely destroyed once stood at the shore at a promontory called Kai-halulu. Kihawahine was its goddess. Dogs, hogs, and red fish were offered there in the olden days. In times of trouble such as sickness, the priests took offerings there

Kamaloʻula Heiau (Site 50-30-10-3076): Located at Kamaloula, that was the site of Makea's house (female). This heiau was built for the purpose of multiplying food plants.

Hoʻai Heiau (Site 50-30-10-75): Located at the birth place of Prince Kuhio. The heiau complex consists of 5 separate platforms all interrelated to each other. Most were paved. . . A round fireplace with sand bottom was noted on one of the platforms. A rectangular pit had two unusual stones shaped like the human foot or lower leg. Evidently these were items o f worship.

Kiha-Houna Heiau (Site 50-30-10-80): Kiha-Houna. Heiau for the gods who are Hulukoki, Kane, Kamohoaliʻi, and Kuhaimoana. The heiau was dedicated to these gods.

Kane-i-olo-uma Heiau (Site 50-30-10-81): . . on the shore a short distance east of site 80. . . . at Poʻipu, Kōloa,. . .

Papa Shrine: Papa was a fish altar on the beach on southern Kōloa. It was a place on which red fish and hogs were offered and was also a place on which the fishermen's first catch as laid (Kikuchi 1963).

Thomas Thrum was the next to discuss sites in the Kōloa area in his list of the *heiau* of Kaua‘i. He discussed six *heiau* in the district of Kōloa, which once extended from Hanapepe to Mahaulepu. The *heiau* were Hanakalauae, Kanehaule (inland Kōloa Ahupua‘a), Kihouna (Kōloa Ahupua‘a), Kaneiolouma (Kōloa Ahupua‘a), Weliweli (Weliweli Ahupua‘a), and Waiopili (Mahaulepu Ahupua‘a). The two *heiau* on the Kōloa coast, Kaneiolouma and Kihouna, were described as: “Near the Po‘ipū beach, at Kōloa, are two walled *heiau* but a short distance apart.” (Thrum 1907:36-37;68)

The earliest systematic archaeological survey on the Island of Kaua‘i was conducted by Wendell Bennett in the late 1920s. Bennett examined and recorded 202 sites on the island. According to his site location map, Sites 50-30-10-74 to 81, 85-86, and 91-92 may be in the *ahupua‘a* of Kōloa (Bennett 1931:98).

Site -85 consists of walls, enclosures, and house sites, “...in the cactus covered country around the Kōloa reservoir and extending to the sea.”

> Innumerable walls, some of them enclosures and some merely division walls and fences. The center one, and the largest, was 10 by 7 feet and 2 feet high. It was built up around the edge with large stones and felled with 2-inch pebbles. On each side of this structure was a 3 by 3 by 2-foot pile of rocks. There are some fine house sites on flat places on the lava flows, slightly leveled with small stones. House sites about 10 by 15 feet are found everywhere on the lava. The walls are of different types of construction and some have been restored for modern use; double rows of large stones on edge felled en small stones; walls built up of same size stones; walls built of blocks of lava set upright. Some walls are 6 feet and others 2 feet high (Bennett 1931).

Site -86 is described as a house site in the same area as site 85 above.

> This special house site is rectangular, 25 feet wide, and 45.5 feet long, enclosed by walls 2 feet wide and about 2 feet high. It is divided into two sections. The south section is paved with small stone and has a terrace across the southern end. East of this section, outside the wall, is a roughly paved irregular area. The roughly paved north section is one foot lower than the south section, the walls being correspondingly higher. Outside the west wall of this house near the center is a paved platform in which is a square depression. The walls of this house site are made of double rows of stones on edge with a small stone fell between them. Coral is found en the walls. Southwest of this site is another, with walls on three sides only, which measures 15 by 15 feet (Bennett 1931:120).

Site -76 consists of numerous salt pans, east of Waikomo Stream along the shore. Site 77 consists of four ponds just inland from the shore road east of site 76. Site 78 is a series of taro terraces and habitation areas, just east of site 77 and adjoining it. Site 79 is a large enclosure and house sites just northeast of site 78.

Site -80, Keha-Houna Heiau, located on the point between the Waeohae and Po‘ipū Beach Hotels, is significant as the only surviving major religious structure located along the south coast of the island of Kaua‘i. It is only one of two *heiau* still located along the entire District of Kona (the other being Polehale Heiau, site 50-30-01-1).

B. Modern Archaeological Surveys in the Kōloa Area

Beginning in the 1960s, several large archeological surveys were carried out in Kōloa. Figure 5 shows the locations of these and other previous archaeological studies in the vicinity of the current project area. Table 2 provides an overview of previous archaeological projects conducted in the vicinity.

William Kikuchi (1963) conducted a general survey of the Kona District of Kauaʻi including all *ahupuaʻa* from Hanapēpē, eastward to Kīpū Kai. Information from Thrum (1907), Bennett (1931), a Lahainaluna School manuscript (1885), and other sources was instrumental in helping to locate major archaeological sites during the field survey. Kikuchi's survey was selective since it was not designed to be a complete inventory, and focused on generally larger or more coastal sites. No sites were recorded as being in the present project area. Kikuchi listed sites mentioned in other sources, but not relocated by him. In Kōloa, this included the *heiau* of Maulili. There are three areas in Kōloa named Maulili, the shore area, called Maulili-kai, the area inland of this, and an area in the town of Kōloa. Kikuchi believed that Maulili *heiau* once was on the shore.

During the 1973-1974 State Wide Inventory of Historic Places performed by ARCH of the County of Kauaʻi for the State of Hawaiʻi, the archaeological remains first identified by Bennett (1931) *mauka* (north) of the present project area (SIHP site -85) were briefly evaluated and placed on Reserve status. Archaeological sites are placed in this category because they need additional research and must be saved until they can be placed into one of the other categories. These include: 1) High Value - sites that must be saved; 2) Valuable - sites that should be saved; 3) Marginal - can be destroyed with reservations; and, 4) Destroyed - all traces obliterated.

Stephen Palama and Catherine Stauder (1973) conducted a reconnaissance survey along the route of the then-proposed main cane haul road to the Kōloa mill site, *mauka* (north) of the present project area. The proposed new section of road extends from Weliweli Road, southwestward across Poʻipū Road, connecting to an existing cane haul road. This road corridor crosses a portion of Weliweli Ahupuaʻa and both east and west Kōloa at a distance of between two-thirds to two miles from the coast. A total of 18 sites were recorded along the road corridor. Although the Palama and Stauder study was limited in scope to the proposed road right of way, it included a short but thorough historical summary of the place of archaeological sites within the context of the Kōloa and Weliweli Ahupuaʻa. An extensive *ʻauwai* system was observed east of Poʻipū Road. The following comments on this system and the sites in general are relevant to understanding the archaeological significance of the area as a whole, and the historic processes at work:

> …the most significant archaeological feature located within the study area is the extensive *ʻauwai* system. Remnants of this irrigation system were observed on both sides of the Waikomo Stream…[This] network of watering canals proved to be the key to the success of the prehistoric Hawaiian Culture in turning these marginal lands into flourishing wet and dry agricultural fields…it is evident that the early commercial growers of sugar cane utilized the existing *ʻauwai* system…as more and more fields came under sugar cane production these replaced the wet and dry fields of an earlier day.

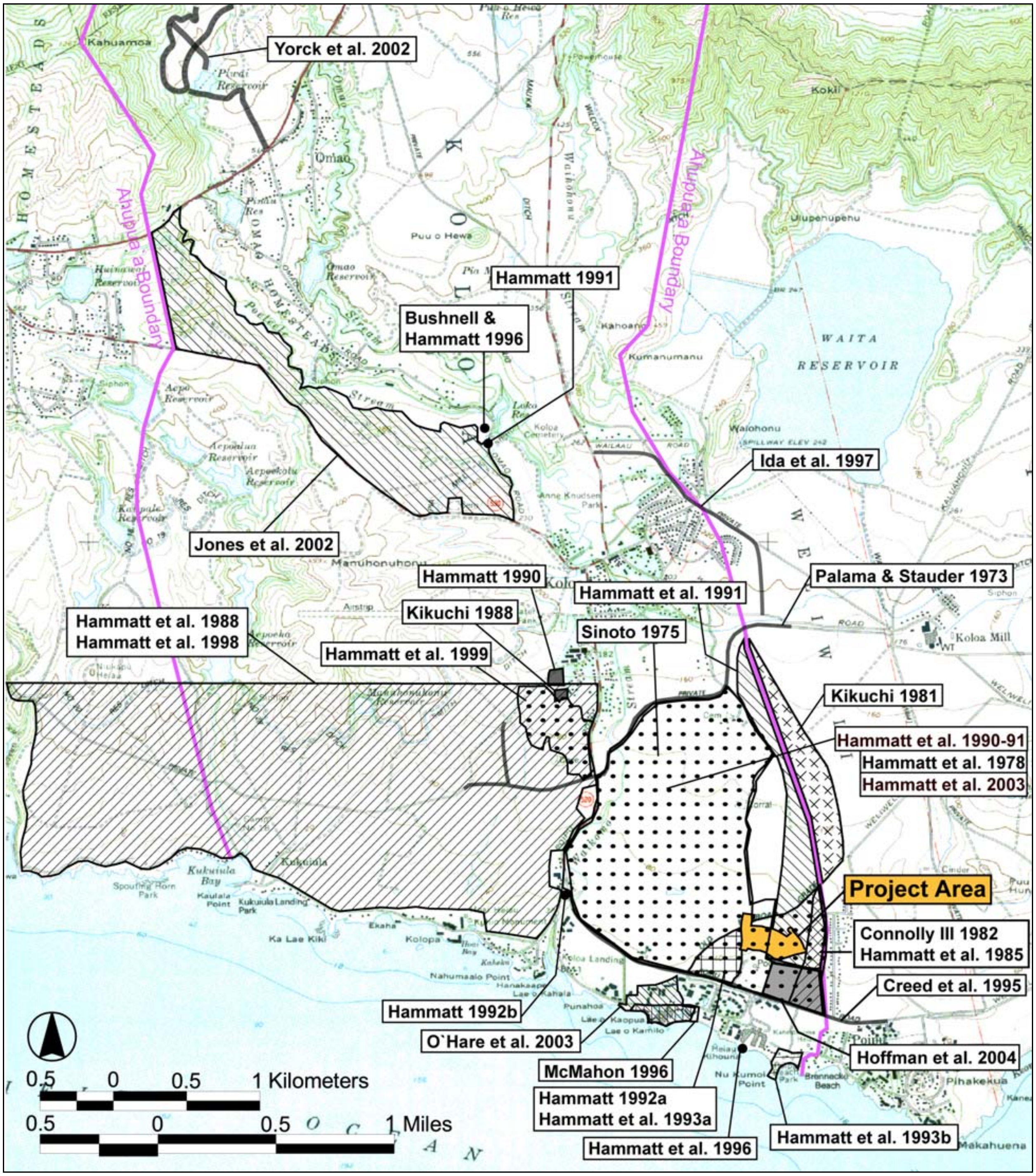

Figure 5. U.S. Geological Survey map, Kōloa Quad., showing project area and locations of previous archaeological studies

A survey by ARCH in 1974 was conducted in the area encompassed by the sewage treatment plant to the southwest of the project area. A portion of a large agricultural complex was recorded.

A surface survey conducted by ARCH of coastal lands (approximately 1000 acres) of the a*hupua'a* of Weliweli, Pāʻā, and Māhāʻulepū was conducted in 1974 (Ching, Palama, and Stauder 1974). Several important sites, specifically the Waiopili *heiau* complex, were located. However, extensive bulldozing and stone robbing had destroyed most of the surface features, making spatial analysis impossible.

In 1977, reconnaissance was undertaken to locate an *'auwai* that was reputed to run from Waikomo Stream to the area of the Prince Kuhio Hotel (Bordner 1977), west of the current project area. A large *'auwai* was found, which corresponds to the major *'auwai* system assigned SIHP site 50-30-10-1934. A portion of an agricultural system to the west of the present study area was also described. In its lower section, the *'auwai* is built up into an aqueduct several feet above the surrounding ground surface; at present, this is a unique feature in the State of Hawaiʻi. Again, bulldozing and historic construction has damaged sections of the agricultural system, but there is no doubt that these sites are similar to those found in the study area.

CSH conducted an archaeological survey for the proposed Kōloa-Poʻipū Bypass Road project (Hammatt et al. 1985), just to the east of the current project area. Archaeological work was completed, however the plans for the road alignment were abandoned and a completed survey report was never submitted to SHPD. A total of 47 previously identified and undocumented sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt et al. (1978). Ten sites, including enclosures and C-shaped structures, were selected for subsurface testing, eight of which are in the current project area. "The testing showed only sparse evidence of occupation with no apparent cultural stratification" (Hammatt et al. 1985). The best examples of sites were recommended for either preservation or data recovery.

Francis Ching (1983) conducted a reconnaissance survey, and an historical investigation of approximately 230 acres of Alexander and Baldwin lands within the *ahupua'a* of Kōloa (west Kōloa) and Lāwaʻi. According to Ching, three-fourths of the study area was bulldozed, with many rocks re-located, however, remnants of walls, *lo'i* (wetland cultivation), ʻ*auwai* (irrigation ditch) flumes, terraces, and an historic railroad berm were still discernable. These remnants are evidence of the great expanse of the Kōloa Field System.

James Landrum (1984), of the Bishop Museum, conducted a reconnaissance survey of an approximately 200-acre portion of Kukuiʻula. Landrum recognized that his survey area was once part of an extensive irrigated agricultural complex developed in the pre-contact period with superimposed historic-era occupation (Landrum 1984:24).

Hallett Hammatt, Douglas Borthwick, David Shideler, and Mark Stride (Hammatt et al. 1988) conducted an archaeological inventory survey in the 1000-acre proposed Kukuiʻula Bay Planned Community, west of the current project area. Fifty-eight archaeological sites were recorded, many associated with the Kōloa Field System. Two to three *heiau* were found, possibly including the remains of Kamaloula *heiau*.

William Kikuchi (1988) conducted a reconnaissance level survey of the former Paʻanau

Sugar Camp, northwest of the present project area. The camp was located just *makai* (south) of the present day Kōloa Elementary School. The survey recorded a number of cement foundations, ditches, and portable historic artifacts. Kikuchi states that archaeologically the site is interesting because it contains remnants of an early (1910-1950) plantation camp, even though the vast majority of its structures have been destroyed or removed.

Hallett Hammatt (1990) conducted an inventory survey of a 4.7-acre parcel at the west end of Pa‘anau Road near Kōloa town, northwest of the present project area. The historical segment of this report indicates the previous existence of the Pa‘anau Camp, and a railroad and ‘*auwai* irrigation ditch which traversed the study area. However, the survey revealed the absence of any traces of pertinent features.

Hallett H. Hammatt (1991) carried out an archaeological reconnaissance for a proposed waterline stream crossing of Pō‘ele‘ele Stream, north of Kōloa town, a significant distance to the north of the present project area. He noted extensive modern land modification and no significant findings.

Hallett H. Hammatt, William Folk, and Mark Stride (1991) conducted an archaeological inventory survey of 160 acres along the Kōloa-Weliweli *ahupua‘a* boundary. The current project area is located within this area. They located, mapped, described, and evaluated 75 sites and observed a wide range of site types. Their survey indicates that the Po‘ipūlani project area was associated with the Kōloa Field System.

Hallett H. Hammatt (1992a) carried out an Archaeological Inventory Survey of a 3.8-acre property at Kīahuna, (TMK 2-8:014-026), but the entire parcel had been previously graded and there were no significant findings. This project is bounded by Po‘ipū Road on the southeast and is west of the current project area.

Hallett H. Hammatt (1992b) carried out an Archaeological Reconnaissance of the Po‘ipū Road and Lāwa‘i Road Junction near the mouth of Waikomo Stream, west of the current project area, but again there were no significant findings, owing to prior land disturbance.

Hallett H. Hammatt, Gerald Ida, and William Folk (Hammatt et al. 1993a) conducted an inventory survey, with limited subsurface testing, of 7.6 acres (TMK 2-8-14:30) in east Kōloa, *makai* (south) of the present project area. This parcel is north of Po‘ipū Road and south of the Old Railroad Grade. SIHP site 3758, a house platform or possible *heiau*, was re-mapped, and three new sites habitation/agricultural complexes were recorded. According to Hammatt et al. (1993:21), these sites are remnants of traditional ‘*auwai*, walls, fields, enclosures and habitation platforms, and appear to be a part of the larger Kōloa Field System, which encompassed over 1000 acres.

Hallett Hammatt, Gerald Ida, William Folk, David Shideler and Brian Collin (Hammatt et al. 1993b) conducted an assessment survey, subsurface testing and monitoring at Po‘ipū Beach Park in the *ahupua‘a* of Kōloa, *makai* (south) of the present project area. Wave action during Hurricane ‘Iniki in 1992 had exposed a cultural layer (SIHP site -745) which needed to be preserved and monitored during the reconstruction and restoration of the park. Auger testing (Hammatt et al. 1993b:11) revealed charcoal, and both traditional and historic midden and artifacts (*i.e.* basalt flakes and fragments, nails, glass, *kukui* shells, and mollusk shells). An historic cemetery (SIHP site -1871), located in the middle of Po‘ipū Beach Park, and other sections of the buried cultural layer beneath the park, were also monitored during the removal of several cement slabs, remnants of a pavilion, picnic tables, and barbecues. Three radiocarbon dates were determined for this layer: the earliest was A.D. 1282-1414 and latest ranged from A.D. 1678-1940 (*ibid*:52). The rich cultural layer, supported by radiocarbon dating, indicates that this shoreline occupation is contemporaneous with the development of the Kōloa Field System. This cultural layer is the “single largest coastal beach deposit in the *ahupua‘a*...of Kōloa” (Hammatt et al. 1993b:65, 66) and greatly contributes to the information bank regarding the cultural development of the Kōloa district.

Victoria Creed, Gerald Ida and Hallett H. Hammatt (1996) reported on an inventory survey within a 1.4-mile corridor along the *mauka* (inland) side of Po‘ipū Road (TMK 2-8-15, 16, 17 & 18) in the *ahupua‘a* of Kōloa and Weliweli, south and east of the present project area. Three sites, including enclosures, a terrace, and the Kōloa-Weliweli boundary wall, survived previous bulldozing of the area and were understood as components of the Kōloa Field System.

Kristina Bushnell and Hallett H. Hammatt (1996) carried out an archaeological investigation of ‘Ōmao Bridge in ‘Ōmao Homestead, a significant distance *mauka* (northwest) of the current project area. The only objects of historical interest noted were the existing bridge and features associated with an old railroad.

Hallett Hammatt, Victoria Creed, and Gerald Ida (1996) conducted an assessment survey of an exposed cultural layer in undisturbed sand deposits at Waiohai Hotel, *makai* (southwest) of the current project area. This layer was disturbed by high wave action during Hurricane ‘Iniki, which completely destroyed the associated reconstructed Kiha Houna *Heiau* (SIHP site -80). Three charcoal samples from this layer were dated to A.D. 1430-1950. The exposed cultural layer supports the potential existence of widespread intact cultural areas along the general shoreline (Hammatt et al. 1996:36, 39).

Nancy McMahon, (April 1996) at the time an independent archaeological consultant, completed a reconnaissance survey southwest of the current project area. The purpose of the survey of TMK 2-08-16:3 (8.444 acres), part of the Sheraton Kaua‘i Resort, was to report on damage caused by Hurricane ‘Iniki. No surface sites or cultural deposits were reported. She noted a sandy deposit up to the foundations of the buildings on the eastern side of the project area near Lae o Kamilo. She suggested that the remnants of beach dunes could still exist and recommended monitoring of any construction in this area in case historic sites, including human burials, were uncovered.

Beginning in December of 1996, reconstruction of areas damaged by the hurricane began at the Sheraton Kauai Hotel (McMahon pers. communication). Excavations took place to construct new buildings on new concrete pads. An intact cultural layer, designated Layer III was uncovered. The cultural layer, Layer III, was a dark sandy layer. After grading of one Pad area was complete, human skeletal remains were found in the excavated material. During monitoring of the rest of the project, a total of ten subsurface features (Features B-K) were discovered. Six were fire pits, one was a stain, one was a concentration of fire-cracked rocks, one was a C-shaped structure, and one was a pig skeleton. Eight burials were also uncovered within Layer III. Six charcoal samples were submitted for radiocarbon age determination for Layer III. These ranged from 20+/- 70 BP to 540+/- 60 BP, indicating that the earliest possible date for the features was A.D. 1400.

Gerald Ida, Victoria Creed and Hallett H. Hammatt 1997) conducted a reconnaissance survey on a 1.2 mile corridor of a proposed bypass road within the *ahupua'a* of Kōloa and Weliweli (TMK 2-8-02:3, 2-8-03:1, 2-8-04:1, 2-8-05:2) that had previously been bulldozed. This road extended from an existing bypass road at the coast to north of Kōloa town, north of the present project area. This survey did not reveal any archaeological sites, and further study was not recommended.

CSH (Hammatt, Chiogioji, Shideler, Borthwick, McDermott and Masterson, 1998) reported on data recovery of the Kukui'ula Planned Community Project Phase 1 area encompassing approximately 219 acres (Hammatt et al. 1998), west of the current project area. The project included excavations at 20 different sites, which encompassed 64 individual features. There were a total of 212 excavation units (212 square meters) and 19 backhoe trenches (only 14 backhoe trenches were chosen for study). Large quantities of midden (approx. 23.7 kilograms) and artifacts (10,635 items) were recovered and are reported on. The artifacts include a wide range of types with both indigenous (2,592 items) and historic (8,043 items) represented. Radiocarbon (C14) dates ranged from circa A.D. 1050 onward. The earliest date came from the habitation/burial cave SIHP site -1927A. In addition to the habitation sites and features dated, seven dating samples from agricultural features were also analyzed.

CSH (Hammatt, Bushnell, Ida, Chiogioji, Creed and Shideler 1999) reported on data recovery work just *makai* and southwest of Kōloa Town on the west side of Waikomo Stream in the northeastern portion of the Kukui'ula Planned Community Phase II Area (Hammatt et al. 1999), northwest of the current project area. The study area is comprised of approximately 33 acres and has been used as a buffer zone between cane lands/pastures and the residential lots bordering Po'ipū Road. While some ten land commission awards lie partially or entirely within the project area, most of these properties were bulldozed in the course of sugar cane cultivation. There were, however, areas, which appeared undisturbed by sugar cane cultivation or heavy machinery. Excavations were conducted within five archaeological sites (13 features). These excavations yielded 264.8 grams of midden; 53 indigenous artifacts (including 43 volcanic glass flakes, 9 basalt flakes, and one coral manuport); and 877 late-historic artifacts (*e.g.* glass, metal, ceramics, plastic, leather, and slate). Twelve charcoal samples were dated, and ranged from A.D. 1250-1410 to A.D. 1800 to present.

Jesse Yorck, David Shideler, and Hallett Hammatt (2002) conducted an inventory survey of three proposed well sites near Pīwai Reservoir north of 'Ōmao Homesteads, located a significant distance northwest of the current project area. No archaeological sites were identified in the project area or vicinity.

In 2003, an archaeological survey was conducted along the coast in the Sheraton Kauai Hotel property, southwest of the current project area (O'Hare et al. 2003). Salt pans, abraded areas, and possible bait cups were recorded along the rocky coast; these may correspond to Bennett's Site 76 "Salt pans, east of Waikomo stream along the shore" (Bennett 1931:98). Five features were noted in the interior section of the project area, two platforms, one mound, one terraced area, and one enclosure. The two platforms were later partially dismantled to test for burials. No human remains or any other cultural materials were recovered from the features.

Table 2. Previous archaeology of Kōloa and vicinity

NAME	YEAR	LOCATION	STUDY TYPE
Bennett	1931	Kukui‘ula Valley, Prince Kūhiō Park	General Survey
Kikuchi	1963	Kona District	General Survey
Kikuchi	1973	Hawaiian Fishponds	General Survey
Palama and Stauder	1973	Cane Haul Road-Kōloa Mill	Reconnaissance Survey
Sinoto	1975	Knudsen Trust Lands	Reconnaissance Survey
Bordner	1977	Kukui‘ula *‘auwai*, Site 50-39-10-1934	Reconnaissance Survey
Hammatt, Bordner and Tomonari-Tuggle	1978	Kīahuna Complex	General Survey
Connolly	1982	Kōloa-Po‘ipū Bypass Road	Reconnaissance Survey
Ching	1983	Kukui‘ula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Landrum	1984	Kukui‘ula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Hammatt, Borthwick and Shideler	1985	Kōloa-Po‘ipū Bypass Road	Survey and Subsurface Testing
Kikuchi	1985	Shoreline Improvements, Waiohai Hotel, Kiha Houna Heiau	Reconstruction
Kikuchi	1988	Pa‘anau Sugar Camp	Reconnaissance Survey
Hammatt *et al*. (Hammatt, Borthwick, Shideler, and Stride)	1988	Kukui‘ula Bay Planned Community	Inventory Survey
McMahon	1989	Kaua‘i Fishponds	General Survey
Hammatt	1990	Pa‘anau Housing Project	Inventory Survey
Hammatt	1991	Pō‘ele‘ele Stream - Waterline crossing	Archaeological Reconnaissance
Hammatt, Folk, and Stride	1991	Po‘ipūlani Golf Course	Inventory Survey
Hammatt	1992a	Kīahuna	Inventory Survey
Hammatt	1992b	Po‘ipū Road and Lāwa‘i Road Junction	Archaeological Reconnaissance
Hammatt, Ida and Folk	1993a	Po‘ipū Road 7.6-acre Parcel	Inventory Survey
Hammatt *et al.* (Hammatt, Ida, Folk, Shideler, and Colin)	1993b	Po‘ipū Beach Park	Subsurface Testing and Monitoring

NAME	YEAR	LOCATION	STUDY TYPE
Creed, Ida and Hammatt	1995	Poʻipū Road	Inventory Survey
Bushnell and Hammatt	1996	ʻŌmao Bridge, ʻŌmao Homestead	Archaeological Investigation
Hammatt, Creed, and Ida	1996	Waiohai Resort	Assessment Survey
McMahon	1996	Sheraton Kauai Hotel	Reconnaissance Survey
Ida, Creed, and Hammatt	1997	Poʻipū Bypass Road	Inventory Survey
Hammatt *et al.*	1998	Kukuiʻula Planned Community Phase I	Data Recovery
Hammatt *et al.*	1999	Kukuiʻula Planned Community Phase II	Data Recovery
Yorck, Shideler, and Hammatt	2002	Kaumualiʻi Highway, Alexander and Baldwin Properties	Inventory Survey
Tulchin and Hammatt	2003	Eric Knudsen Trust Lands	Field inspection

C. Previous Archaeological Studies Specific to the Project Area

Akihiko Sinoto (1975) conducted a reconnaissance survey of approximately 400 acres of Knudsen Trust Lands at Kōloa including a portion of the current project area. He recorded several features and suggested they were the northern remnants of Bennett's Sites 78, 79, 85 and 86. Large numbers of sites were located, with the concentration of both habitation and agricultural features along the southern portion of the study area, from the sewage treatment plant to the Weliweli subdivision. Sinoto recommended more intensive survey and subsurface testing for the parcel.

Archaeological sites in the project area were located and described as part of the archaeological survey in support of the proposed Kīahuna Golf Village project by the Archaeological Research Center Hawaiʻi (ARCH) (Hammatt et al. 1978). An archaeological report was completed, however its status with the SHPD as an accepted inventory survey report is unclear. A total of 583 features were recorded in a total surveyed area of 460 acres. The current project area was covered as the *makai* (southern) portion of the Kīahuna survey area designated Area C. Sites were located and described with no subsurface testing. Both habitation and agricultural sites were located in the current project area, including stone enclosures, platforms, *ʻauwai* (irrigation ditches), and terraced plots. Selective preservation or data recovery was recommended for sites in the Kīahuna Golf Village project area as "they represent a highly significant cultural resource of substantial value for archaeological research and interpretation" (Hammatt et al. 1978).

An archaeological inventory survey was conducted for the proposed 160-acre Poʻipūlani Golf Course project (Hammatt et al. 1991), of which the current project area was a portion. The report was reviewed and accepted by SHPD along with a data recovery and preservation plan for the property (Hammatt 1991). A total of 75 sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt et al. (1978). Sites previously identified in the

Kīahuna Golf Village and Kōloa-Po‘ipū Bypass Road projects were relocated and assigned SIHP site numbers. Preservation was recommended for “major sites,” and “all other sites which cannot be incorporated into the development should be subjected to a program of data recovery including subsurface testing and excavation” (Hammatt et al. 1991).

D. Settlement Model Based on Results of Previous Archaeological Work

From previous archaeological studies and historic accounts it appears that habitation and intensive irrigated agriculture were widespread in central and coastal Kōloa utilizing the opportunity to develop an extensive irrigated complex (the Kōloa Field System) off of Waikomo Stream. As the Judd (1935) account asserts, it is likely that low inland areas were used for less intensive cultivation of patches of sweet potato, *pia*, and *wauke* and the gathering of *hala*, *kukui* and other resources. The coastal portion would be a focus for permanent habitation, collection of marine resources, ceremonial activities, and burials.

Chronological analysis from Kōloa, and the two neighboring *ahupua‘a*, Pa‘a and Weliweli, suggests an early initial occupation within the Pa‘a Ahupua‘a of circa A.D. 535 (Walker and Rosendahl 1990:131). No coinciding early dates have been found within Kōloa Ahupua‘a, probably due to vagaries of sampling since most of the shoreline area of Kōloa has been heavily impacted by commercial, residential, and resort development. Initial occupation probably was characterized by temporary and/or recurrent occupation. From A.D. 600-1400, settlements in the Kōloa area were still limited to the coast. By A.D. 1040, lava tubes were used for burial and temporary habitation in the inland areas of Kōloa (Hammatt et al. 1999:7).

Beginning possibly as early as 1450, the ‘Kōloa Field System’ was planned and built on the shallow lava soils to the east and west of Waikomo Stream. The Kōloa Field System is characterized as a network of fields of both irrigated and dryland crops, built mainly upon one stream system, that of Waikomo Stream, adapted into an inverted tree model with smaller branches leading off larger branches; with dispersed housing and field shelters among the fields, particularly at junctions of *‘auwai*, the whole contained within the entire *makai* portion of the *ahupua‘a* of Kōloa stretching east and west to the *ahupua‘a* boundaries and possibly into Weliweli Ahupua‘a.

The field system, with associated clusters of permanent extended family habitations, was in place by the middle of the 16th century and was certainly expanded and intensified continuously from that time. Long *‘auwai* were constructed along the tops of topographic high points formed by northeast to southwest oriented Kōloa lava flows. These *‘auwai* extended all the way to the sea. Habitation sites, including small house platforms, enclosures and L-shaped shelters were built in rocky bluff areas which occupied high points in the landscape and were therefore close to *‘auwai*, which typically ran along the side of these bluffs. From A.D. 1650-1795, the Hawaiian Islands were typified by the development of large residential communal residences, religious structures and an intensification of agriculture. Large *heiau* in Kōloa may date to this period.

In the early post-contact era (A.D. 1795-1880), the Kōloa Field System continued to produce goods, mainly for use in foreign trade, and was probably further intensified. Sweet potatoes were a major crop for the whaling and merchant ships, and pigs, salt, oranges and other items are noted in many ships’ journals. *Kuleana* documents show that by the mid-1800s there were still several traditional farmers within Kōloa who lived and worked within the area. The individual claims for both *lo‘i* (wetland) and *kula* (dryland) suggest that, while traditional farming of taro for subsistence was still taking place, sugar cane production for sale to the nearby sugar mill had begun to dominate in *kula* lands. Of the Land Commission Awards (LCAs) within Kōloa, several claim a *kula* planted with cane or a cane field or sugar cane garden. Several also identify cane lands as boundaries for the LCAs. Clearly, *kula* lands in the project area were being converted into sugar lands at a rapid rate. Only three years had passed since the opening of Ladd and Co. and already residents in and surrounding Kōloa were adapting to an economy based on the production of sugar cane. Eventually most of inland Kōloa was planted with sugar cane and only the most rocky and unsuitable cultivation areas survived the dramatic changes in the landscape brought about during the early twentieth century.

IV. RESEARCH OBJECTIVES

A. Research Goals

1. Chronology

At the present time, there are no quantitative dates available for the project area. However, a series of C14 dates have been obtained for the adjacent Kīahuna project that contains a similar pattern of land use and habitation. Kīahuna dates show cave occupation at or after A.D. 1000 and surface permanent habitation sites dating to 1500 or after. One surface site now destroyed was dated to A.D. 890-1170 from a sample collected in 1979. This date is considered anomalously early for surface sites in the area. An *ʻauwai* cross-section trench, excavated in 1979, yielded charcoal from the base dating A.D. 1325-1430. The general pattern appears to be early occupation of caves and the beginning of irrigated agriculture around A.D. 1400. Chronological information from habitation and agricultural features in the Poʻipūlani area could help expand and refine this tentative chronology. This chronology could be refined at the upper end through dating of historical debris, bottles, nails, ceramics, coins, etc., within historical sites associated with agricultural activities.

2. Origin and Development of Irrigated Agriculture in Kōloa

It is probable that the development of the field systems occurred over a considerable span of time and a certain amount of evolution of design and configuration took place. This would affect subsistence and settlement patters. Information related to this question would be obtained not only from dated materials but the study of stratigraphic relation of agricultural and habitation features. Although soil deposits are fairly thin in many areas it should be possible to locate superimposed agricultural features indicating different phases of development, i.e. stone terraces under earthen terraces, terraces under walls or habitation sites over fields. Through interpretation of these data, it may be possible to reconstruct construction sequences and to infer patterns from these sequences. Fieldwork to address this question would involve backhoe trenching of *ʻauwai* sections and other agricultural features as well as hand excavation in selected areas.

3. Post Contact Acculturation and Economic Change

This question particularly applies to the modification of the agricultural system to produce cash crops for the merchant ship trade centered from Kōloa Landing from the mid-19th Century onwards. The question may be elucidated through excavation and dating of historic occupation sites and discerning the final alterations in the agricultural fields before abandonment. A search of historic records for crops produced, their location and tonnage exported may also be of value.

4. Coordination with Other On-going Projects

CSH was involved with two other projects in the immediate vicinity, which contain similar sites of the same archaeological complex. This complex stretches on both sides of Waikomo Stream and includes the Kīahuna and Kukuiʻula project areas. CSH is attempting to coordinate information from all three of these areas to construct a general picture of what may be termed the Kōloa Field System. Because of the proximity and similarity of the project areas, the information gathered from one will be complimentary and directly relevant to the others. This is particularly true in the case of chronology of origin and development. It is predicted, for example, that the areas directly adjacent to Waikomo Stream on the west and east would have been the earliest to be developed for irrigated agriculture. One would expect expansion to proceed away from the stream on either side. The development of the pre-contact system in the Poʻipūlani area may be one of the later phases in the growth of this complex. This again underscores the need for quantitative dates from a wide range of features.

V. DATA RECOVERY RESULTS

Four historic properties were excavated for data recovery within the Phase 1 Development Project area. These properties are listed in Table 3 and located on Figure 6.

Table 3. List of Historic Properties for Data Recovery

SIHP # 50-30-10-	Function	Site Type	Significance	Number of Trenches Excavated
-908	Temporary Habitation	Modified Outcrop	D	1
-909	Temporary Habitation	Modified Outcrop	D	2
-969	Agriculture	*'Auwai*	D	2
-973	Agriculture	*'Auwai*	D	3

A. SIHP Site -908

SIHP #: 50-30-10-908 (Figure 7)

Function: Temporary Habitation

Site Type: Modified Outcrop

Total Features: 1

Dimensions: 7 m by 6.1 m

Description: SIHP site -908 is a large, low-paved, temporary habitation platform with a probable hearth in the center. Numerous medium-sized slab boulders are laid flat on the platform surface with pebble and cobble fill. Dimensions are 7 m E/W by 6.1 m N/S. An *'auwai* section (Site -969) approaches the platform from the north, circles around the east side of the platform and exits away from the platform to the south, branching into two possible channels or more. One channel may go towards the east. Platform elevation is no more than 50-60 cm above the surrounding ground surface, which is a natural boulder outcrop, sloping five degrees to the south. No cultural material (midden or artifacts) whatsoever were observed on the surface. This site is estimated to be pre-contact in age.

The sub-feature, a probable hearth, is a shallow depression located within the platform surface (Figure 7). The sub-feature is constructed from a crude circular alignment of cobbles measuring 21 cm in height. The circular depression measures 82 by 86 cm and is approximately 21 cm deep. The interior portion of the sub-feature is filled with small cobbles.

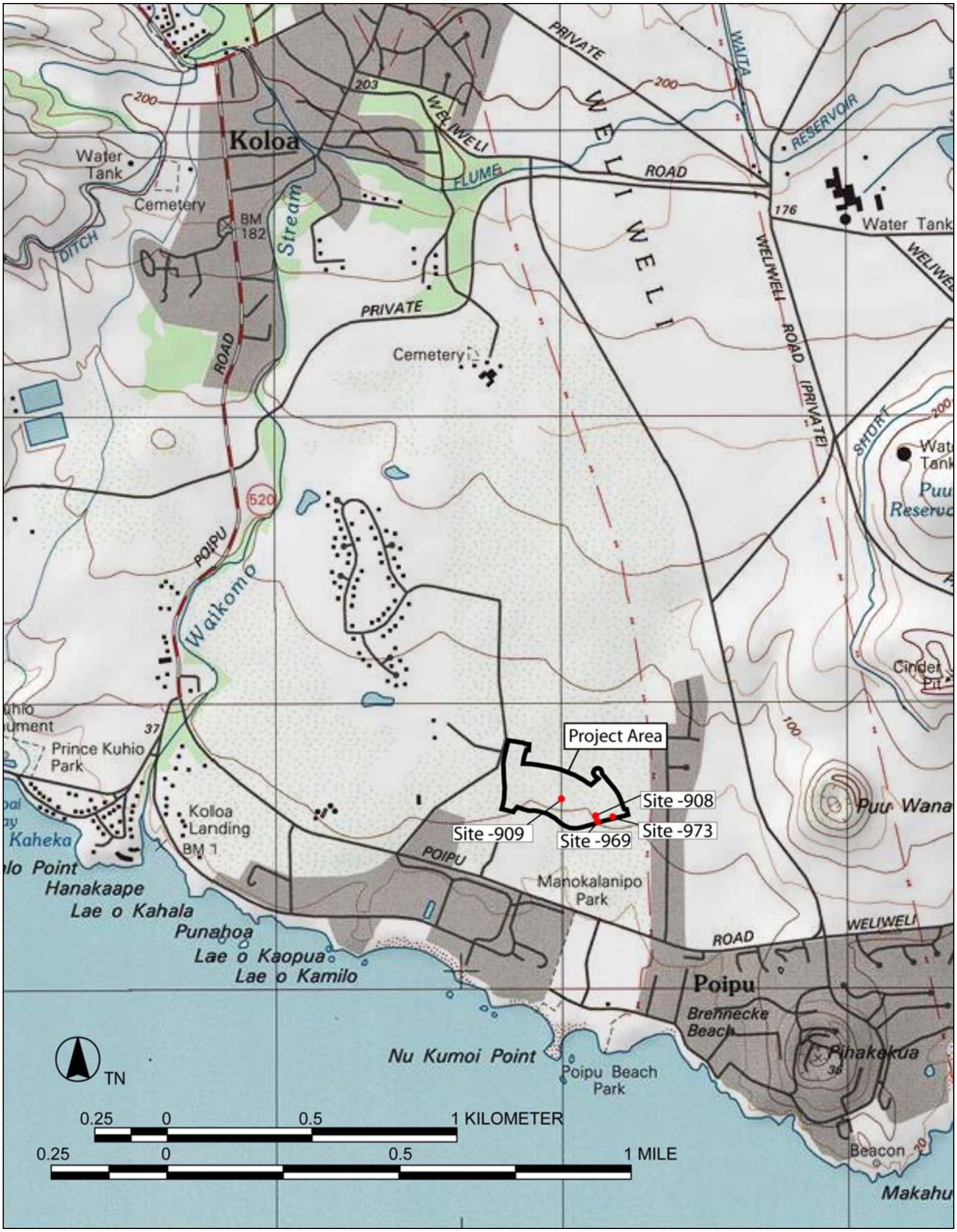

Figure 6. USGS Map showing location of data recovery sites within the Phase 1 Project Area

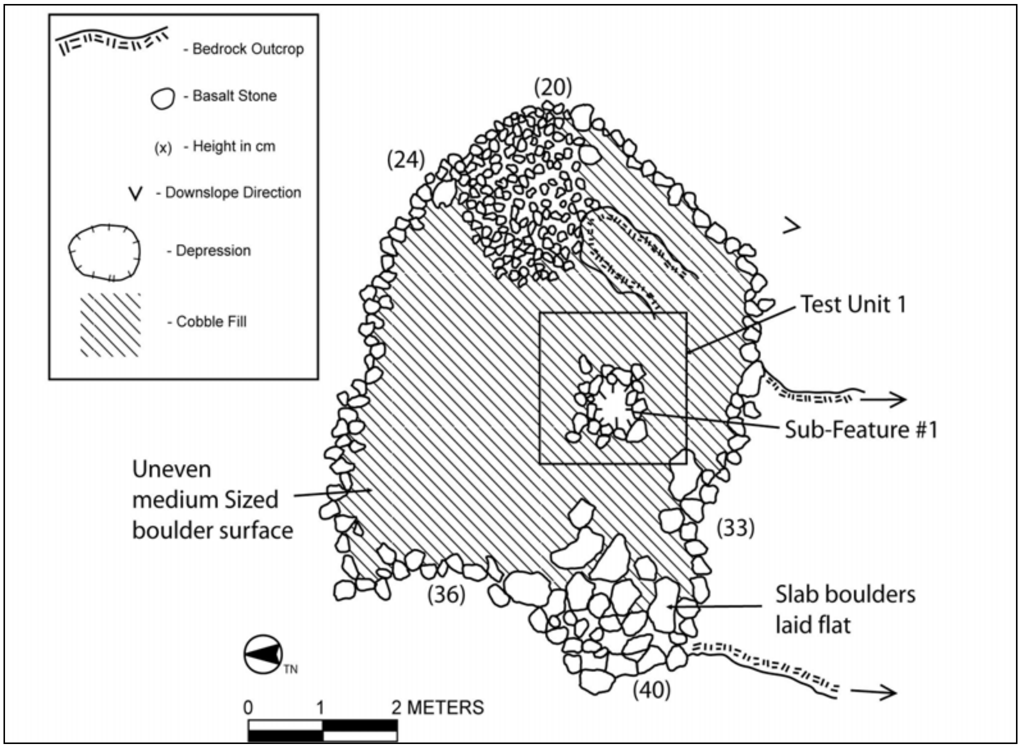

Figure 7. SIHP site -908 plan view

1. Trench 1

Trench 1 (Figures 8-13) of SIHP site -908 was a 2 m^2 trench located over sub-feature 1. No soil was observed on the surface of the trench, only small to large pebbles and cobbles were present with approximately 2 cm of dead organic matter composed of dead grass, *haole koa* leaves, and *haole koa* branches. The surface appeared to be a remnant of a collapsed platform paving comprised of small to large pebbles and extended to approximately 30 cm below the surface and was sterile with no cultural materials.

Stratum I, comprised of soil, was encountered at 65 cm below datum and extended down to a maximum depth of 79 cm below datum and ranged between two to five cm in thickness. No cultural material was recovered from stratum I, however, on the stratum's surface, a few small fragments of shell and coral were located. Shell and coral collected consisted of *Nerita Picea*, *Conus Spp*., *Periglypta Reticulata*, coral, and of unidentified shell.

Stratum II was a loose, silt loam, with small to large cobbles naturally scattered throughout the entire trench. This stratum appeared to be the initial natural ground surface upon which the structural level of SIHP site -908 was built upon. It also appeared that the sub-surface feature had no association with the structural fill level of the platform, and may pre-date the platforms construction. Charcoal fragments, coral, shell fragments, and a basalt flake were collected from stratum II. This cultural material appeared to be evenly distributed throughout the entire trench.

Stratum III contained sterile soil and had a slight change in color from stratum II, with a lighter color to it, and also appeared to be slightly courser than stratum II. Small fragments of decomposing bedrock and gravel were mixed in the lower portion of Stratum III. This stratum ended at 119 cm below datum in the southeast corner at bedrock.

The sub-feature, an ash hearth, was observed at 70 cm below datum in the southeast corner of the trench. The hearth was circular in shape, measured 55 cm east/west and 25 cm north/south. The southern and eastern portions of the feature extended out of the trench and were very visible in the southern and eastern profiles. This feature was screened separately and yielded charcoal, marine shell, and small fragments of coral. The sub-feature appeared to have been dug down into the stratum at 90 cm below datum, and extended down to a depth of 105 cm below datum.

Trench 1 Stratigraphy

Stratum I	70-75 cmbd	Soil Horizon A; 10 YR 3/1, very dark gray; medium, silt loam; weak, medium, single grain; dry, dry loose, moist loose, wet non-sticky, non-plastic; no cementation; terrestrial; abrupt, wavy; none
Stratum II	75-85 cmbd	Soil Horizon B; 10 YR 2/2, very dark brown; medium, silt loam; moderate, medium, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, wavy; charcoal, marine shell, coral; initial level upon which structure was built upon
Sub-Feature A	70-100 cmbd	10 YR 4/2, dark grayish brown; fine, silt loam; weak, fine, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; very abrupt, smooth; charcoal, marine shell, coral fragments; fine ash from hearth, two soil samples taken
Stratum III	85-105 cmbd	Soil Horizon C; 10 YR ¾, dark yellowish brown; medium, silt loam; moderate, medium, granular; dry, dry weakly coherent, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, smooth; none; sterile soil, bedrock

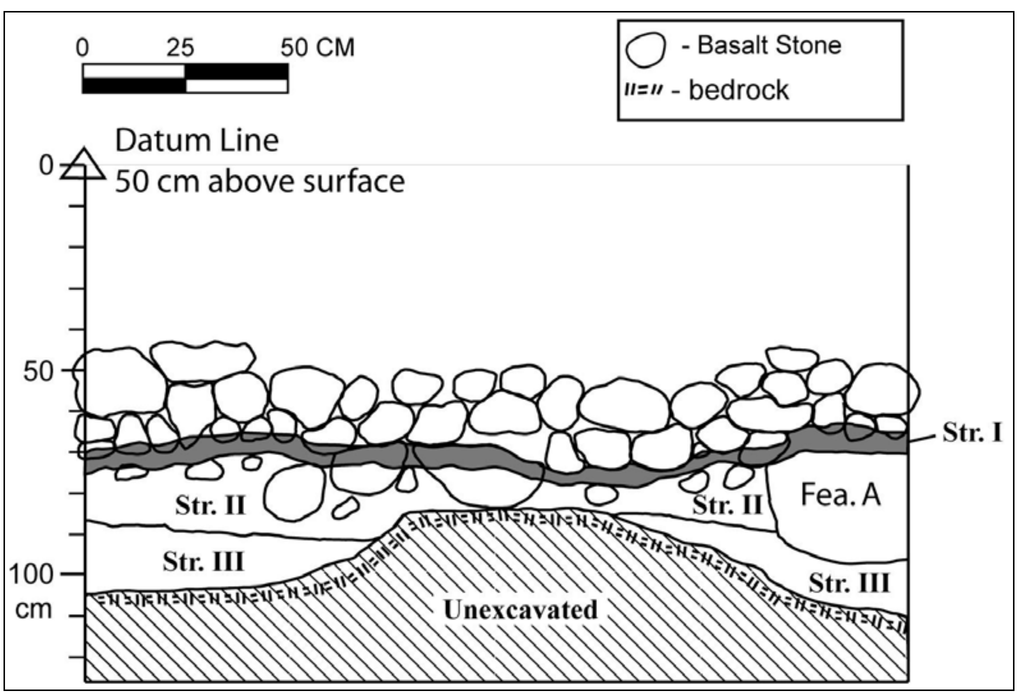

Figure 8. SIHP site -908 trench 1 east wall profile

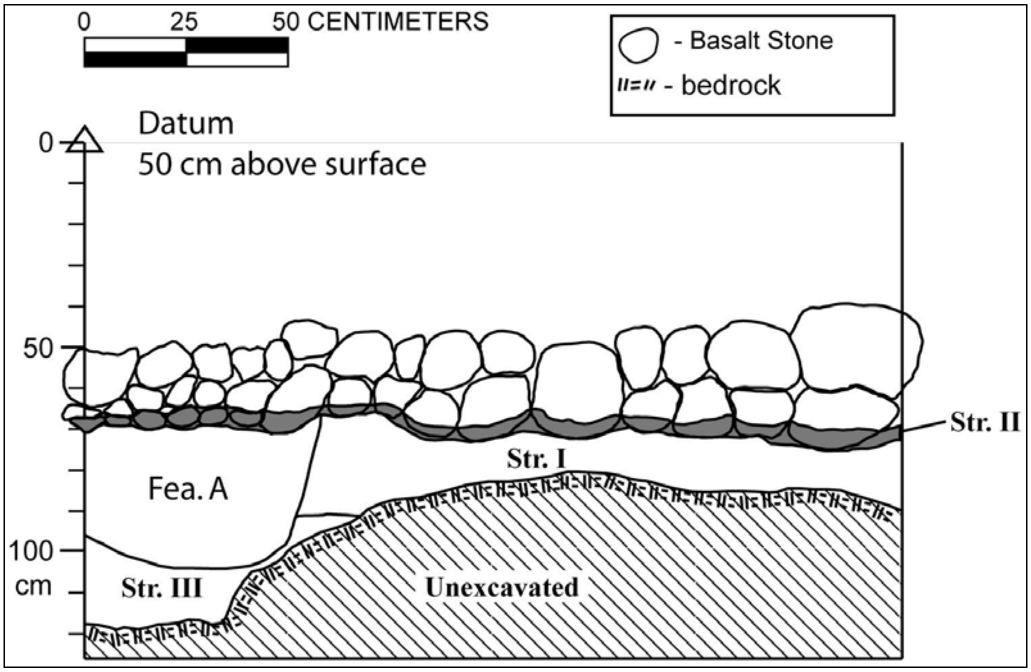

Figure 9. SIHP site -908 trench 1 south wall profile

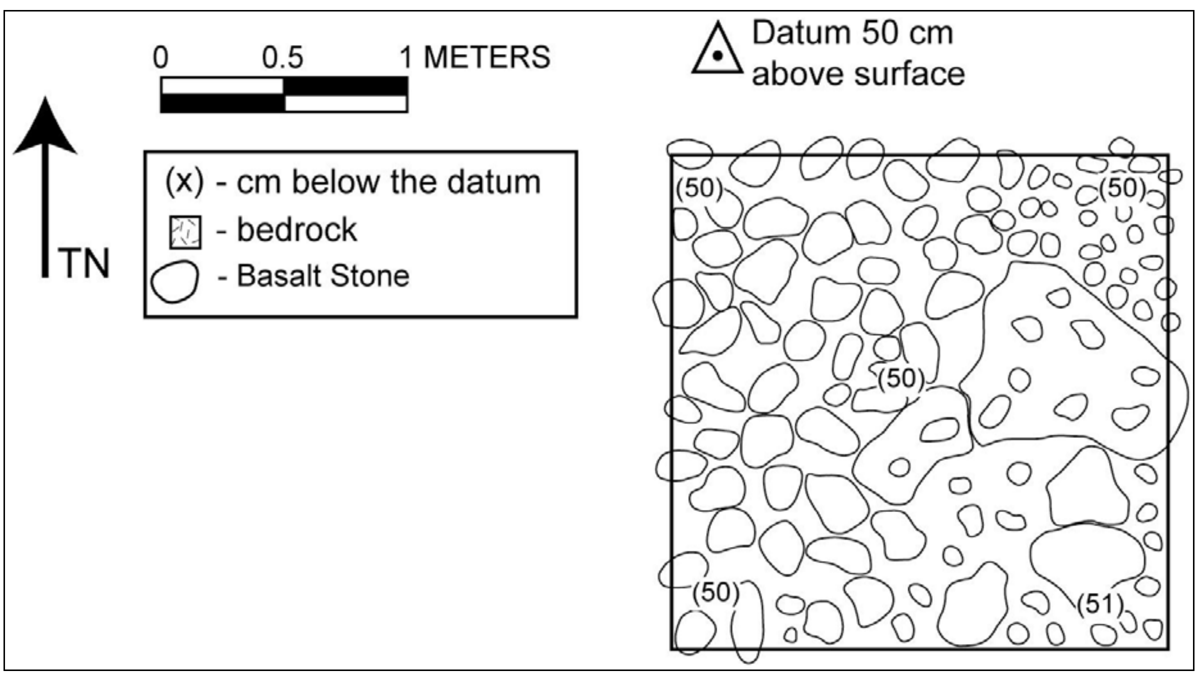

Figure 10. SIHP site -908 trench 1 pre-excavation plan view

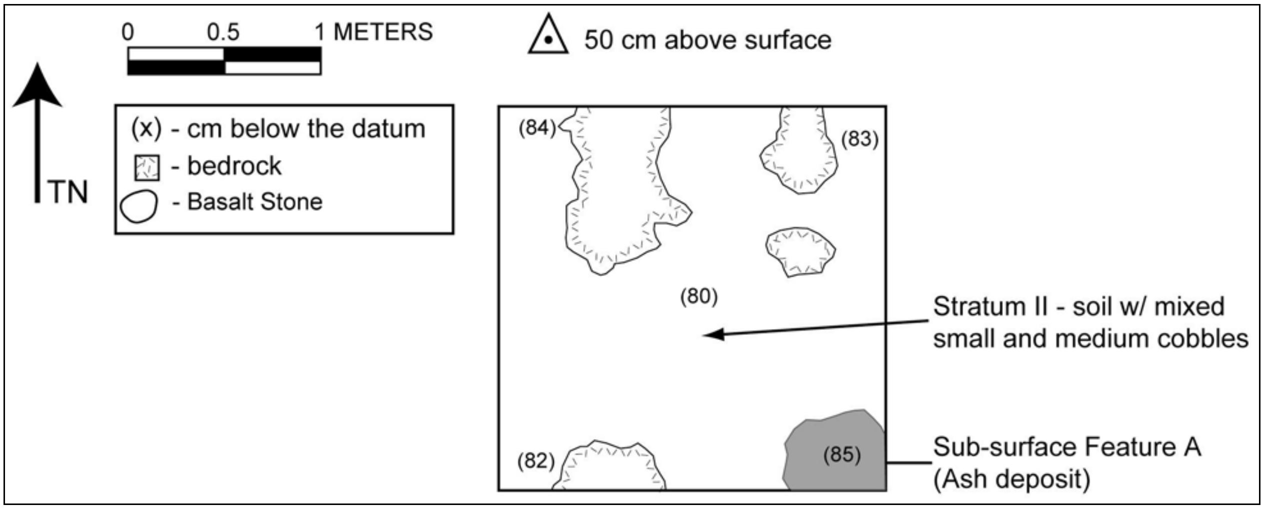

Figure 11. SIHP site -908 trench 1 mid-excavation plan view

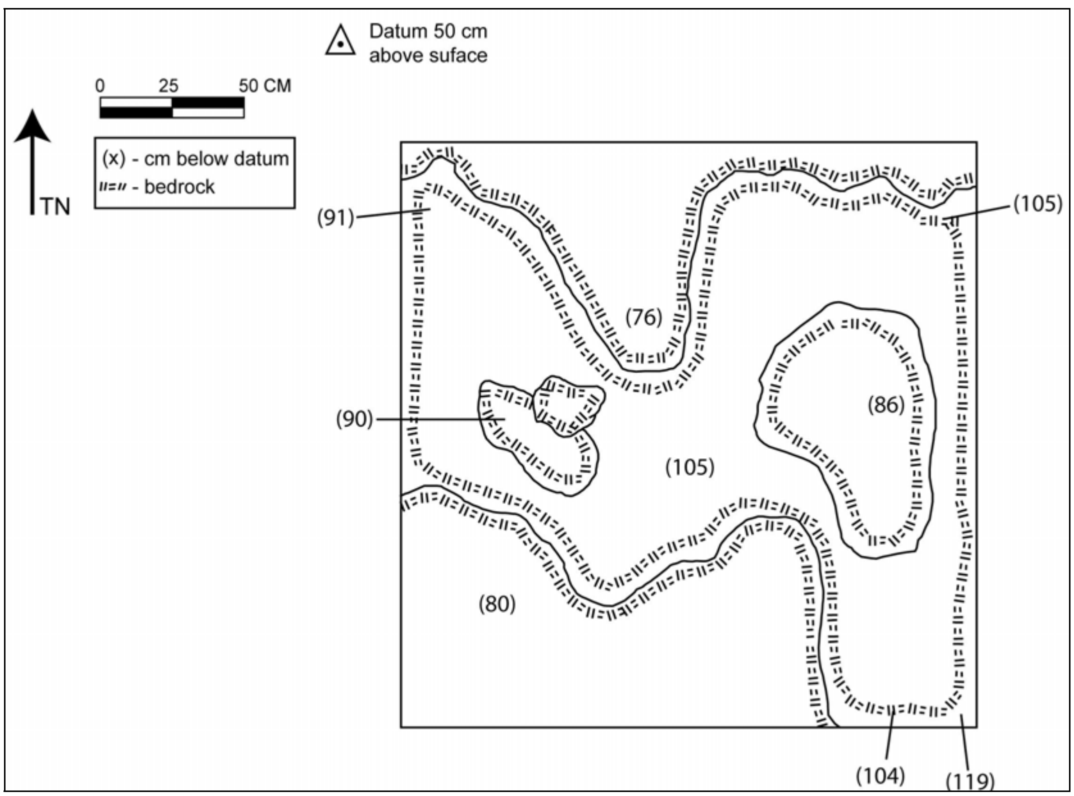

Figure 12. SIHP site -908 trench 1 bottom of excavation plan view

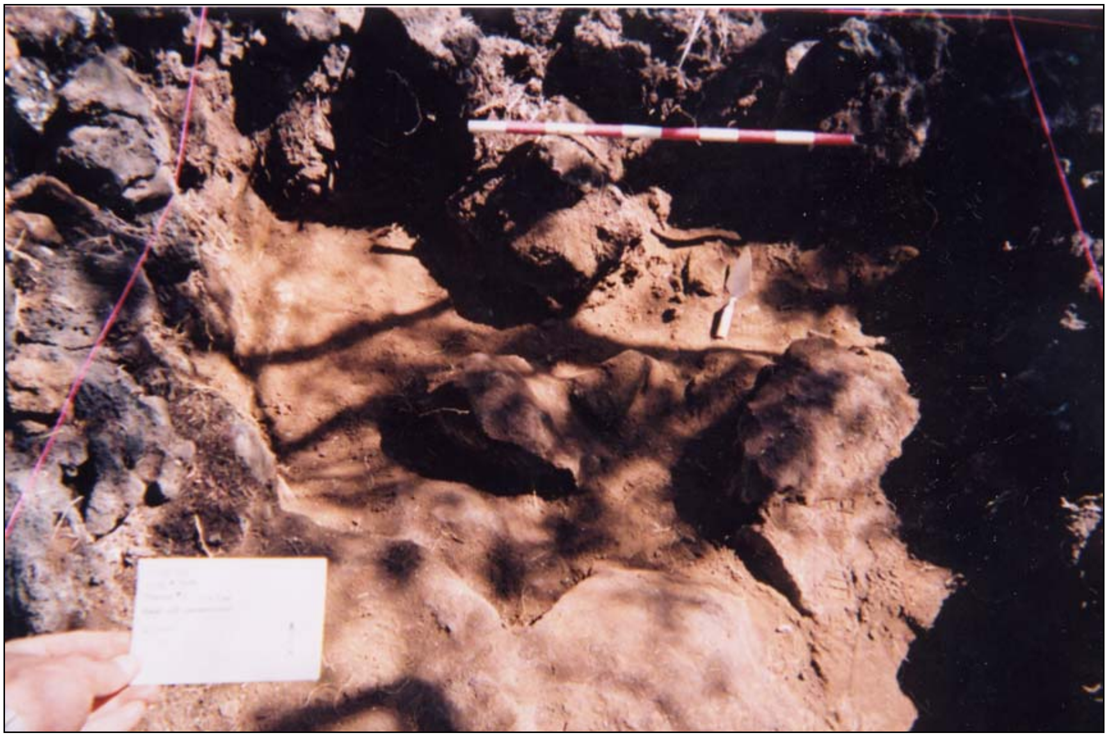

Figure 13. SIHP site -908 trench 1 base of excavation, view to the north

B. SIHP Site -909

SIHP #:	50-30-10-909 (Figure 14)
Function:	Temporary Habitation
Site Type:	Platform
Total Features:	1
Dimensions:	7 m by 6.1 m

Description: SIHP site -909 is a two-level, probable temporary habitation platform, constructed of large boulders off of a high outcrop which slopes towards the south. The platform is approximately 6.5 m wide E/W, and is divided into two terrace levels. The N/S dimensions of each terrace is approximately 4 m. Bulldozing on the north side has disturbed the north edge of the platform. There is a possible fireplace in the upper level of the platform, centrally located, measuring 40 cm by 50 cm with a depression of 22 cm. It is surrounded on the south and east and west sides by very rocky, small agricultural fields and on the north side by very recent intensive bulldozing. The platform is constructed of large boulders with pebbles and cobbles forming the surface of the upper level. A number of small boulders laid flat construct the paving of the surface. Two other nondescript pits are present, one at the joining of the upper and lower levels of the platform and one on the west side of the upper level of the platform. These are possible cupboards that have been opened in the past and left open. The upper platform surface is relatively level with the ground surface to the north. The southern facing of the lower level platform is approximately 1 m in height. The elevation difference between the upper and lower levels of the platform is approximately 50 to 70 cm. No cultural material (no midden or artifacts) was observed.

1. Trench 1

Trench 1 (Figures 15-18) of SIHP site -909 was located on the north terrace running from the center portion and bisecting the north wall. The northern portion of the trench surface was rocky and appeared to be a collapsed wall with large 40 cm by 40 cm cobbles and boulders lining the base of the wall on both the north and south sides. These large cobbles were not set into the sub-surface of the ground, but were resting on the ground surface. The interior of the wall was core filled with many small to medium sized cobbles and pebbles. The base of this wall terminated on top of the terrace paving at 89 cm below datum.

Stratum I was comprised of a natural alluvial soil, which had settled amongst the outcrop. This stratum was very loose and dry and had settled among the cracks of the small boulders. The bedrock at the base of the trench was very uneven and rocky.

Trench 1 Stratigraphy

Stratum I	110-135 cmbd; Soil Horizon A; 7.5 YR 3/4, dark brown; silt loam; weak, coarse, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; none
Stratum II	135 cmbd; bedrock

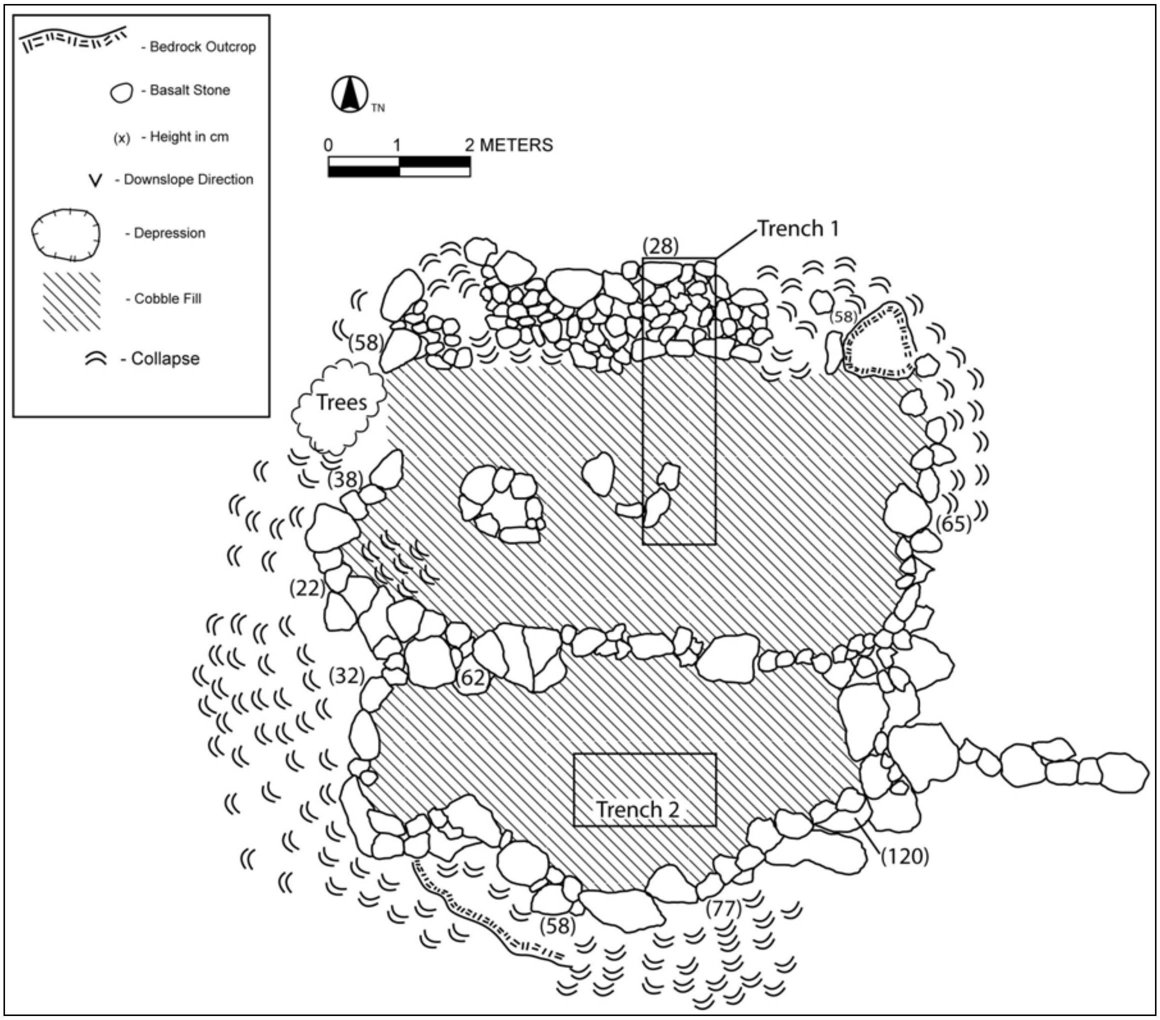

Figure 14. SIHP site -909 plan view

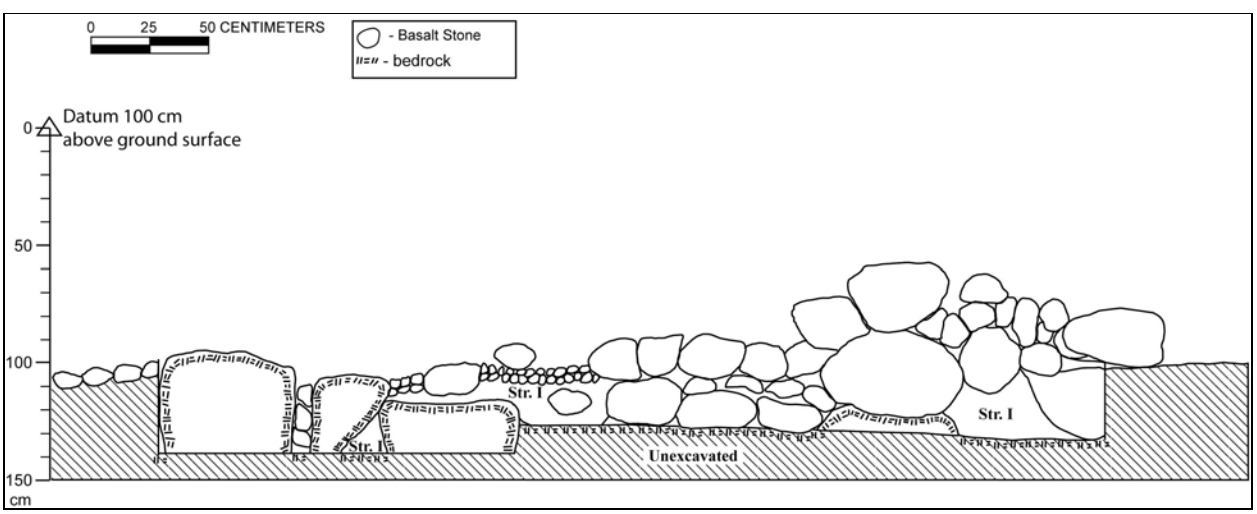

Figure 15. SIHP site -909 trench 1 profile of west wall

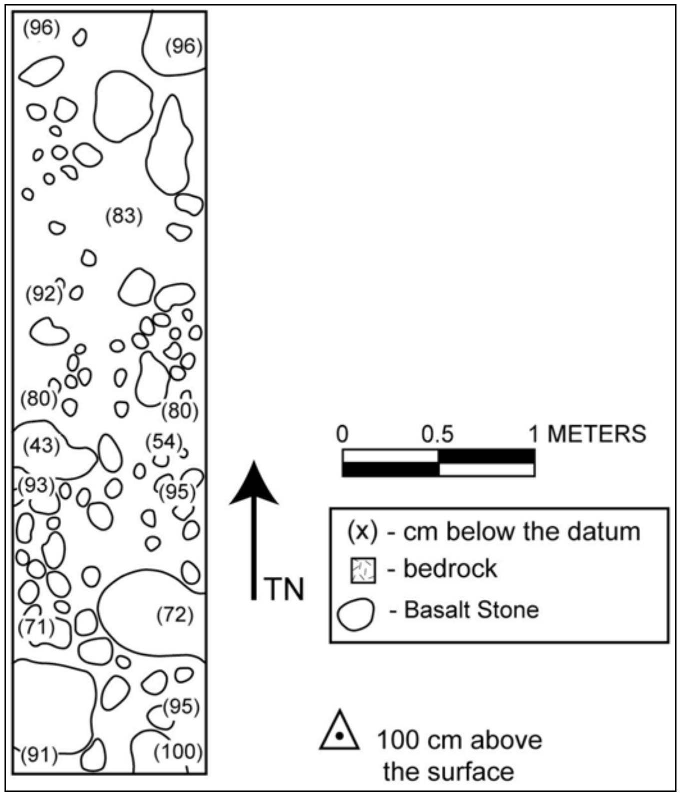

Figure 16. SIHP site -909 trench 1 plan view at pre-excavation

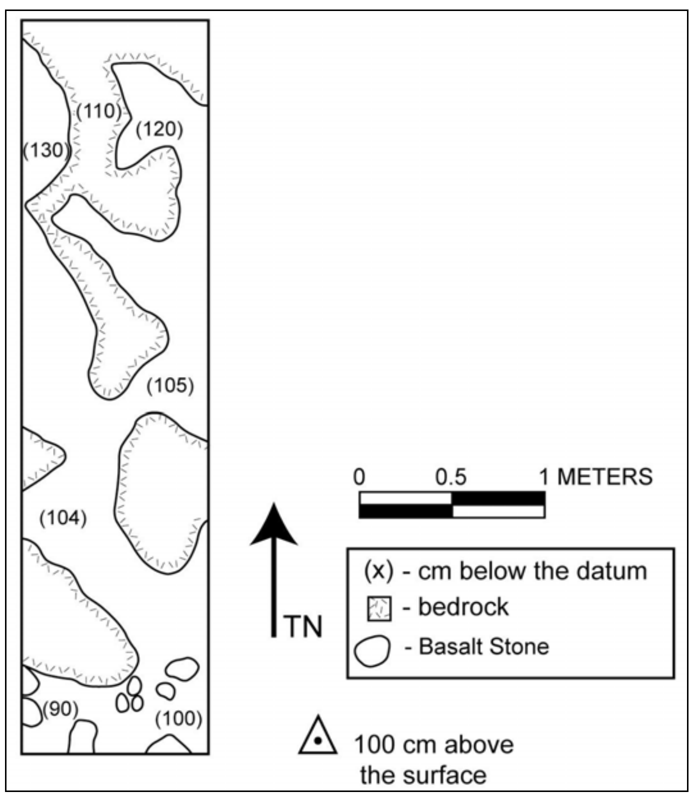

Figure 17. SIHP site -909 trench 1 plan view at mid-excavation

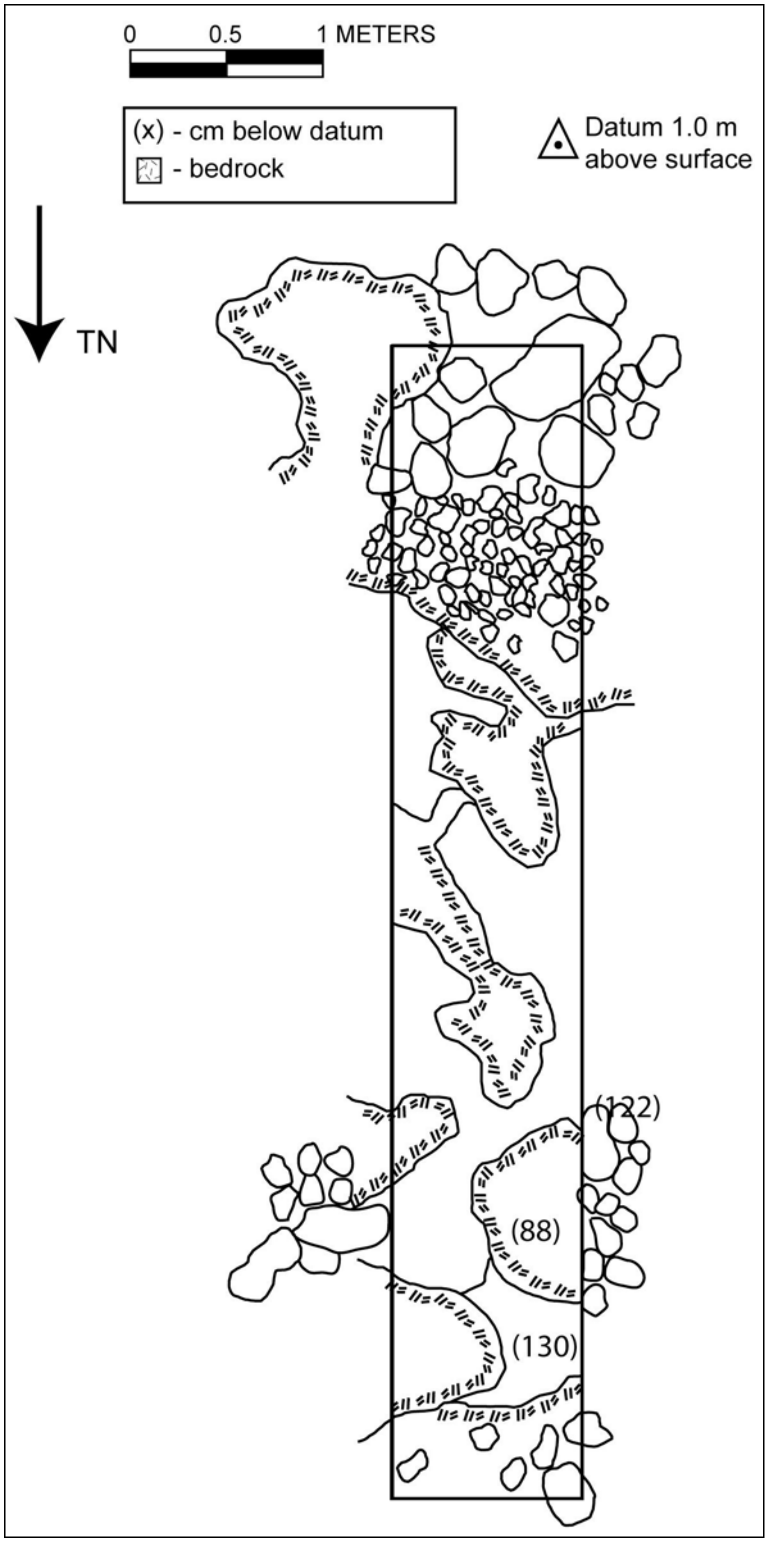

Figure 18. SIHP site -909 trench 1 plan view at post-excavation

2. Trench 2

Trench 2 (Figure 19-21), a 1 by 2 m trench, was located in the center of the southern platform, with the 2 m length running east to west (Figure 14). The surface of trench 2 was rocky with dead organic matter and had a gentle slope towards the south.

The cobbles on trench 2 appear to be a partially collapsed paving of the southern terrace. The structure of SIHP site -909 at trench 2 was removed and was present from 35 cm below datum to 115 cm below datum. It appeared that the stepped terrace was a two-level natural outcrop prior to being modified into a stepped terrace. It also appeared that the constructed parts of the stepped terrace sat on top of the lower natural outcrop and that the cracks of the natural outcrop were filled with boulders and cobbles. There were no cultural materials encountered during the excavation or during the removal of rocks. Excavation of trench 2 was terminated at bedrock.

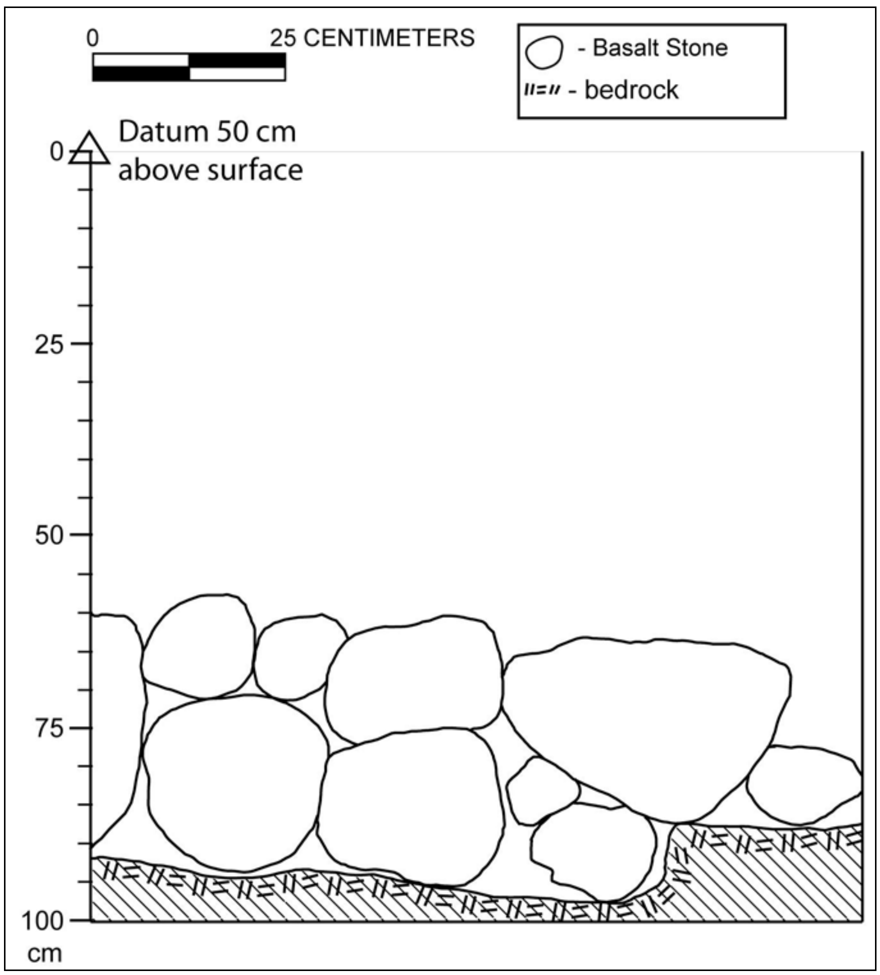

Figure 19. SIHP site -909 trench 2 profile of west wall

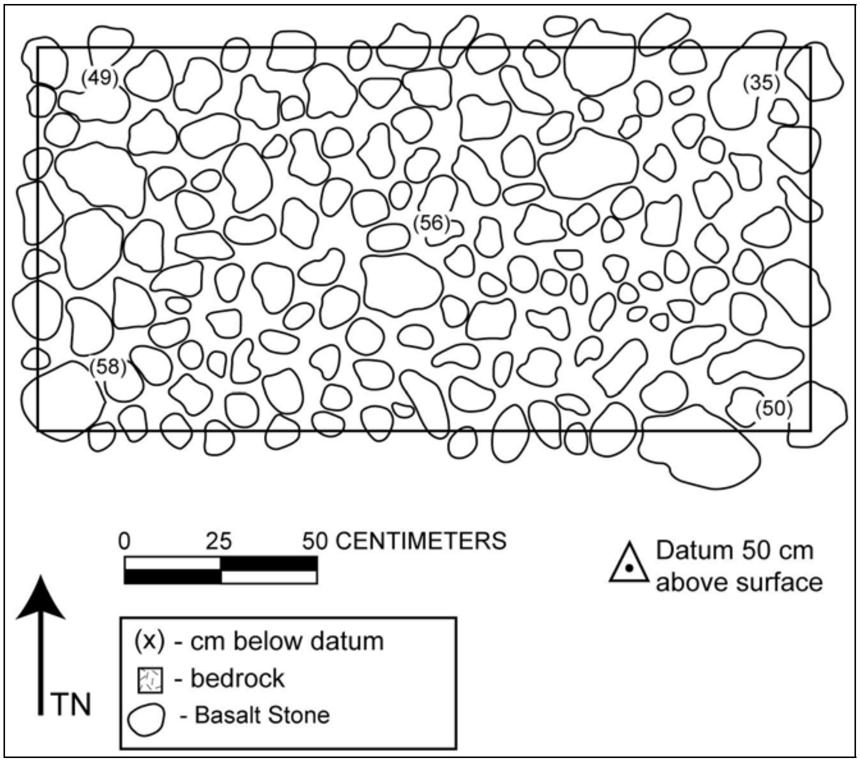

Figure 20. SIHP site -909 trench 2 plan view at pre-excavation

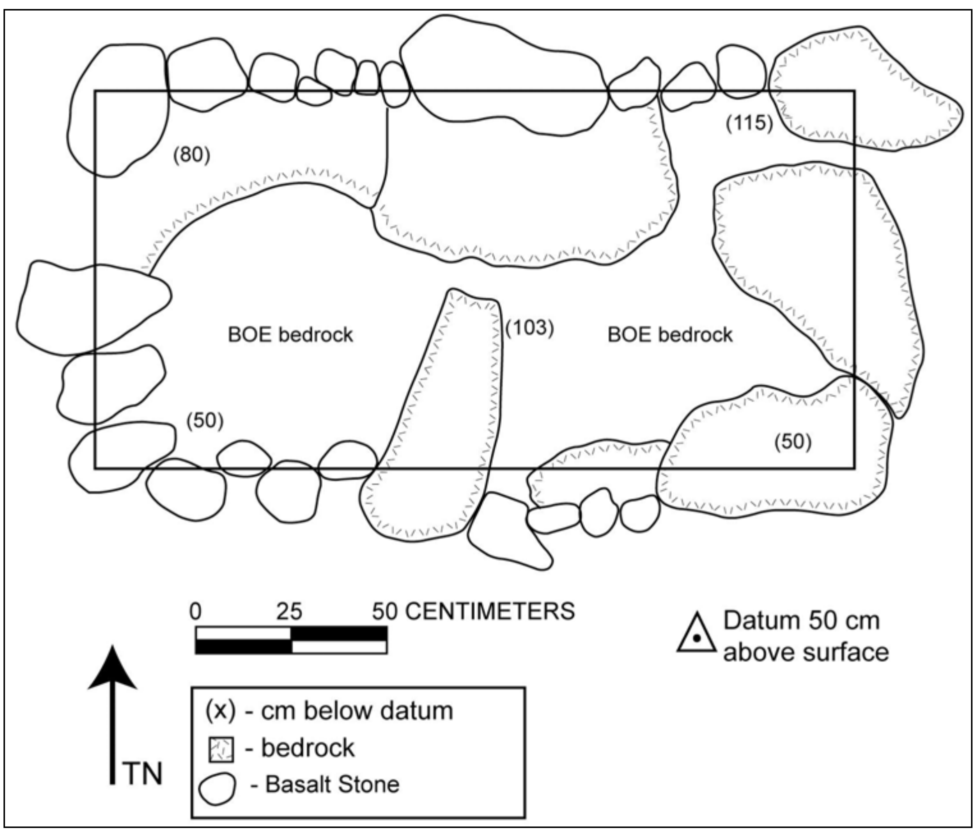

Figure 21. SIHP site -909 trench 2 plan view at post-excavation

C. SIHP Site -969

SIHP #	50-30-10-969 (Figure 22)
Function:	Agriculture
Site Type:	‘Auwai
Total features:	1
Dimensions:	.9 m by 69 m

Description: SIHP site -969 is an *‘auwai* which runs to the east side of SIHP site –908. It is a .9 m wide depression with high rock mounds on either side measuring .9 m wide and .3 m high. The *‘auwai* starts at a bulldozed area at the north end and runs south for 69 m. A possible branch of this *‘auwai* turns 90 degrees to the east where it may have joined the *‘auwai* of SIHP site –973 but the connection is unclear. The main branch terminates at this branch, as it is not traceable beyond this point. This *‘auwai* is of pre-contact age and probably fed fields south of the project area. It was probably used in historic times for sugar cultivation or may have drained fields north of it.

No cultural materials were observed on the surface of the *‘auwai*.

1. Trench 1

Trench 1 (Figures 23-25) was a 1 m by 2 m trench that cut across the northern section of SIHP site -969, a small *‘auwai*. Trench 1 was placed here and cut across the entire *‘auwai* bisecting both the eastern and western walls, to determine the depth of the channel and walls of the *auwai,* and to collect charcoal if possible.

The surface of stratum I was fairly flat and level with a slight five to eight degree slope to the southwest. Small boulders on the eastern and western portions of the *‘auwai* were exposed on the surface with the interior of the trench being the *‘auwai* channel. Vegetation on the surface included thick buffalo grass and *haole koa*. Much dead organic matter such as leaves, grass, and branches were also present on the surface.

Stratum I was loose and sterile with no cultural material. The small boulders of the walls were removed from the surface and revealed approximately two to five cm of stratum I built up around the base of the boulders. Stratum I ranged from five to ten cm in thickness and extended to 56 cm below datum.

Stratum II was dry, lose, and sterile with no cultural material. The surface of stratum II was fairly flat and level with soil covering almost the entire trench. Bedrock was encountered at both the eastern and western sides of the trench, however, no defined outline of the *‘auwai* channel could be identified in the walls profile of stratum II.

Stratum III had a surface that was rocky with uneven and decomposed bedrock. Stratum III had sterile soil that mixed in between the cracks of the bedrock and ended at 75 cm below datum.

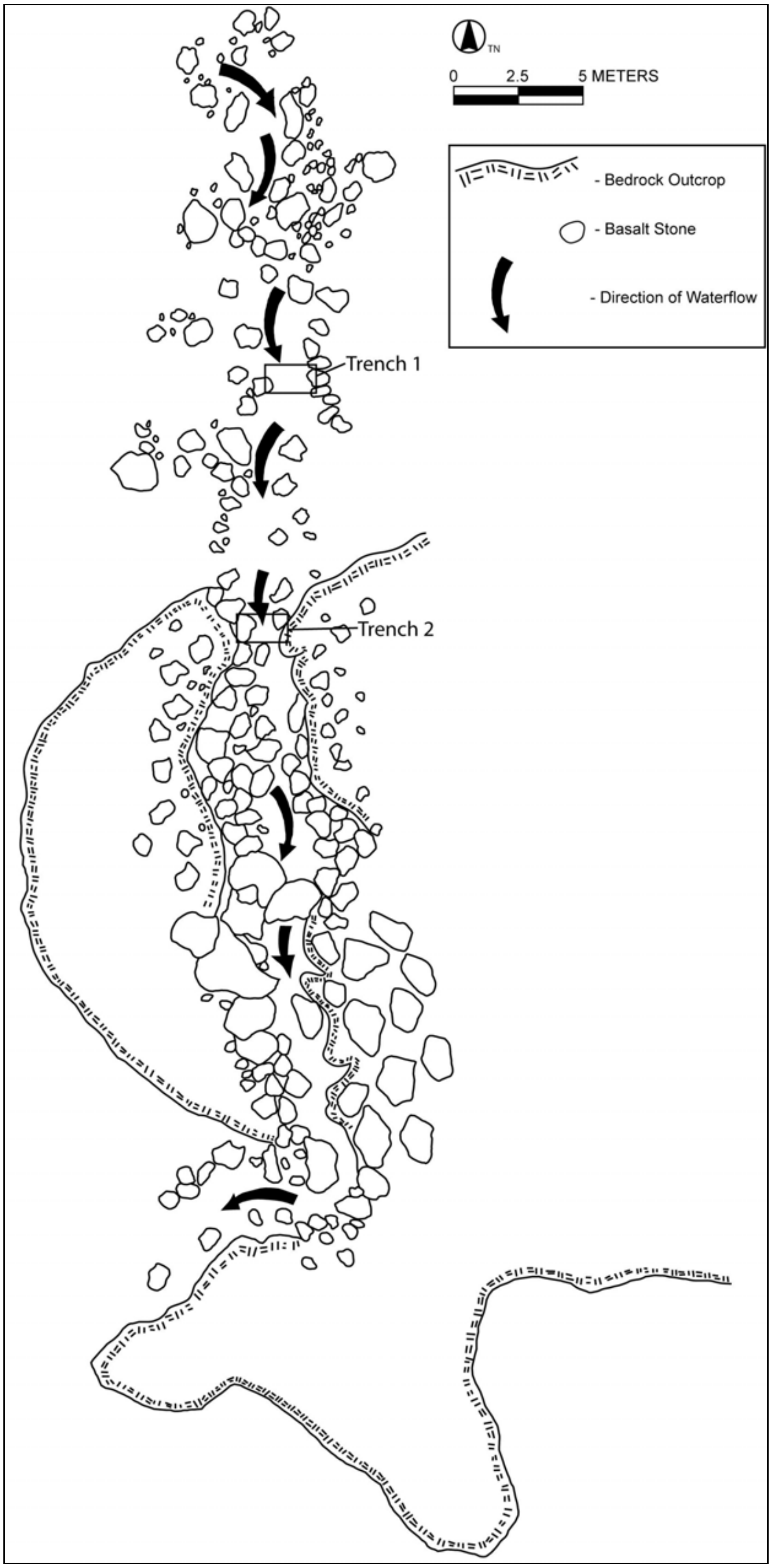

Figure 22. SIHP site -969 plan view

Trench 1 Stratigraphy

Stratum I	40-50 cmbd	Soil Horizon A; 10 YR 3/1, very dark gray; weak, medium, single grain; dry, loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt; wavy; top organic and decomposed organic matter/mulched soil, many small rootless
Stratum II	50-70 cmbd	Soil Horizon B; 7.5 YR 3/4, dark brown; medium silt loam; weak, medium, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt; wavy; only change from I to II is a slight change in color and texture, slightly larger ped size than in stratum II
Stratum III	70-80 cmbd	Soil Horizon C; 10 YR 3/4, dark yellowish brown; medium coarse silt loam; moderate, medium, granular; dry, dry weakly coherent, moist loose, wet non-sticky; non plastic; no cementation; terrestrial; abrupt, irregular; none; sterile level bedrock.

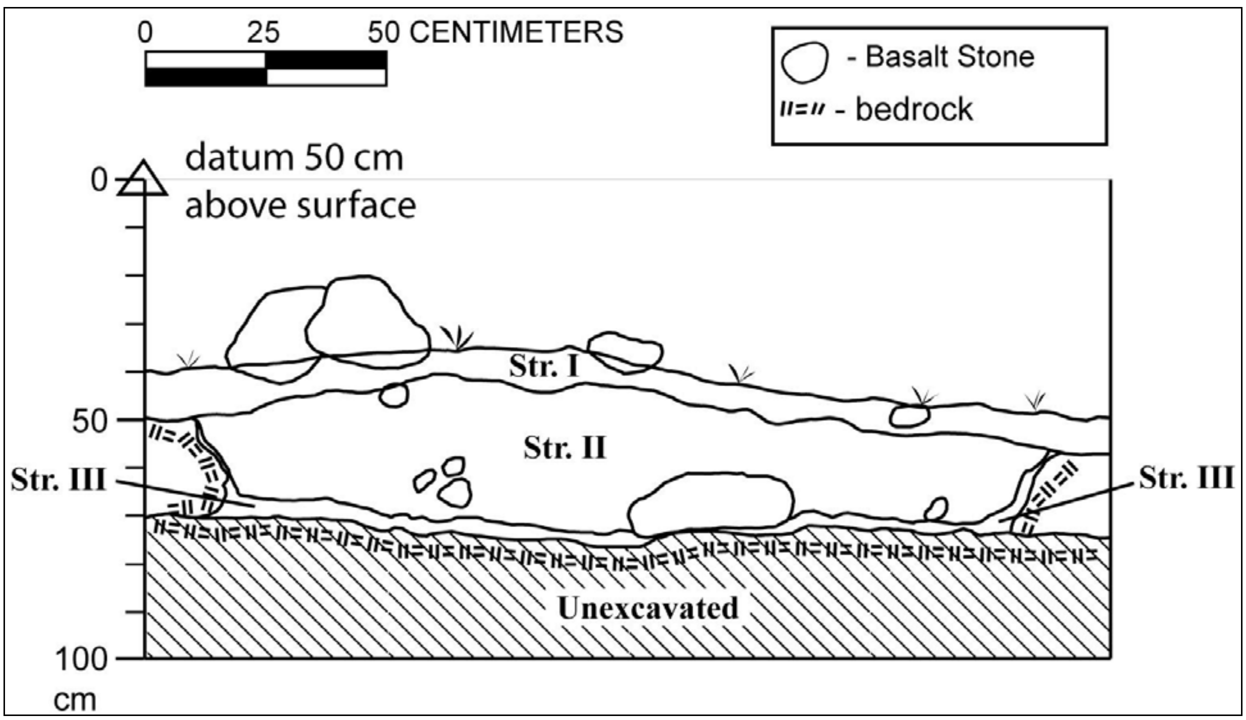

Figure 23. SIHP Site -969 trench 1 profile of north wall

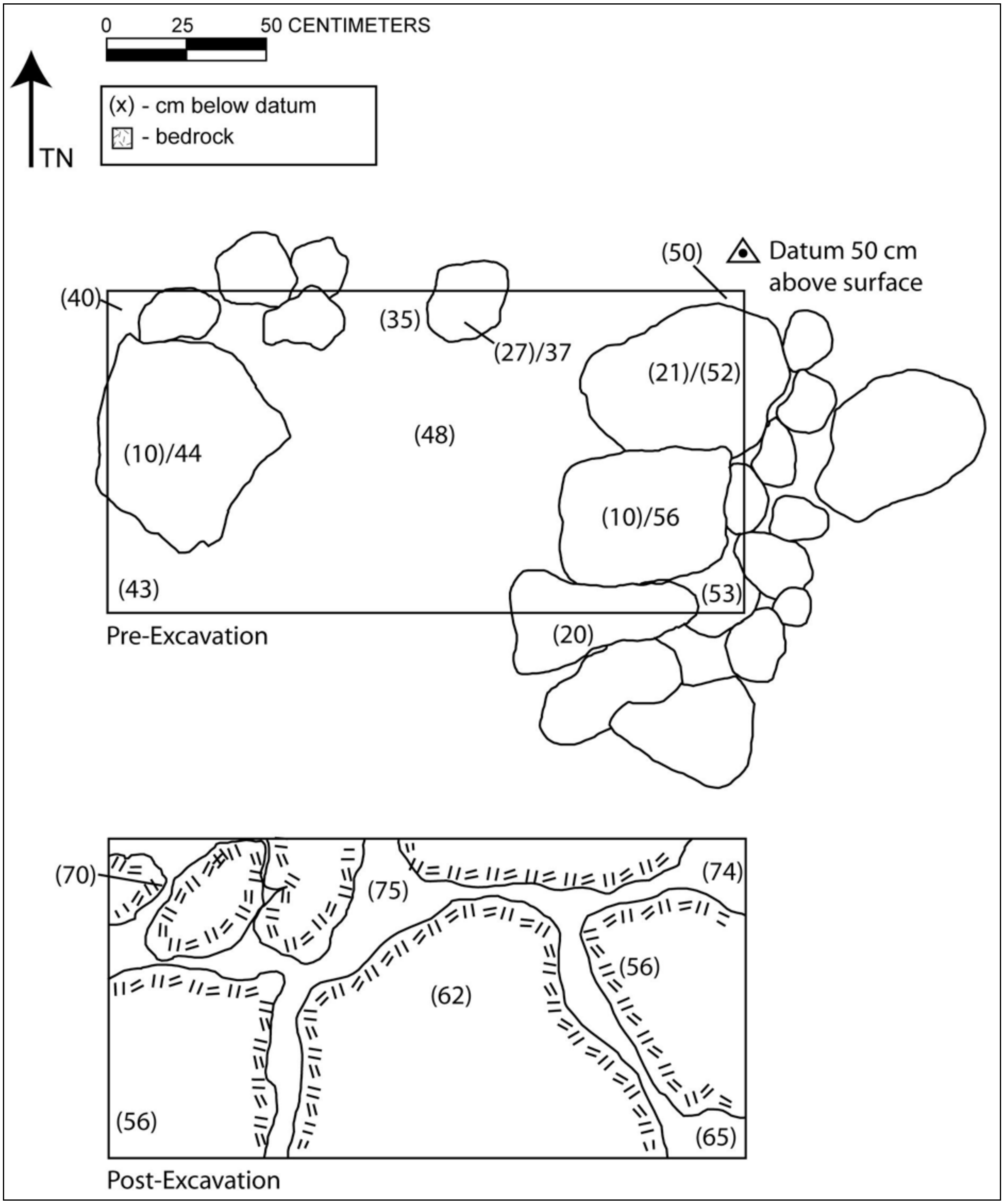

Figure 24. SIHP site -969 pre-excavation and post-excavation of trench 1

Figure 25. SIHP site -969 trench 1 base of excavation, view to the north

2. Trench 2

Trench 2 (Figures 26-28) was 1 m by 2 m and oriented to the north with the length of the trench running east to west (Figure 22). Trench 2 was placed here to cut across the *‘auwai* bisecting both the eastern and western stone boundaries and to determine the depth of the channel and walls of the *‘auwai*, and to collect charcoal if possible.

The surface of trench 2 was rocky and uneven with a rock outcrop in the eastern portion of the trench. There were small boulders to the west with fairly level soil in between the rock outcrop and small boulders. The surface had decomposed organic matter such as dead branches and leaves. The surface had approximately a five to ten degree slope to the south.

Stratum I was very loose and sterile with no cultural material. The stratum ranged from three to five cm in thickness and ended at 75 cm below datum. The small boulders of the western side of the *‘auwai* were removed from the surface with approximately three to five cm of stratum I naturally built up around the base.

Stratum II was dry, loose, and sterile with no cultural material. No defined outline of the *‘auwai* channel was observed within this stratum. Stratum II continued throughout the entire trench extending under the small boulders on the western portion of the *‘auwai* channel.

Stratum III surface was comprised of rocky uneven bedrock and decomposed bedrock crumb mixed in loose soil. Stratum III had sterile soil that appeared to be mixed in between the cracks of the bedrock and ended at 90 cm below datum.

Trench 2 Stratigraphy

Stratum I	60-65 cmbd	Soil Horizon A; 10 YR 3/1, very dark gray; medium, silt loam; weak, medium, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, smooth; top organic and decomposed mulched soil, many small rootlets
Stratum II	65-85 cmbd	Soil Horizon B; 7.5 YR, dark brown; medium, silt loam; weak, medium, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, smooth; only change from I to II is a slight change in color and texture, slightly larger ped size in II
Stratum III	85-95 cmbd	Soil Horizon C; 10 YR 3/4, dark yellowish brown; medium coarse, silt loam; moderate, medium, granular; dry, dry weakly coherent, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, irregular; sterile level, bedrock

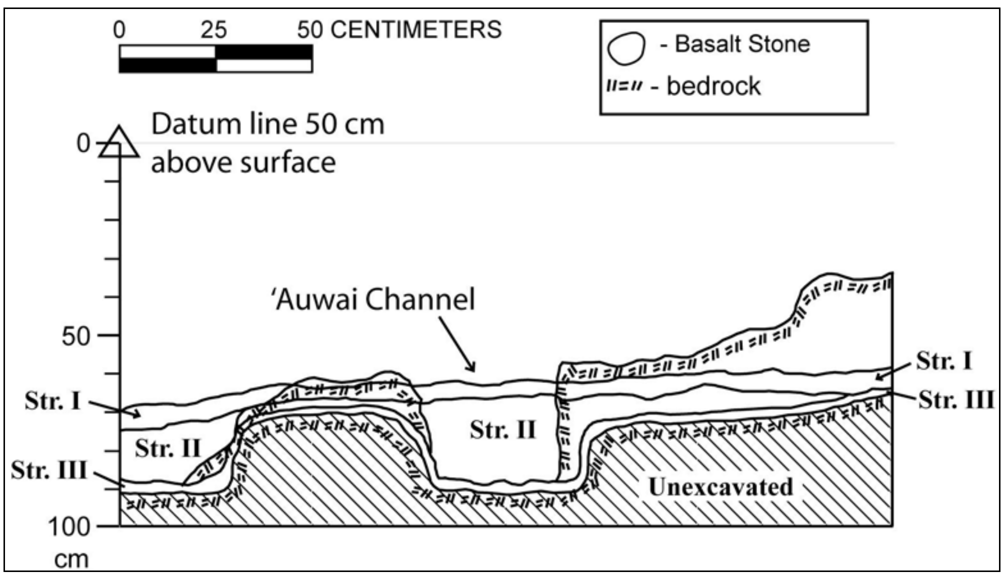

Figure 26. SIHP site -969 trench 2 north wall profile

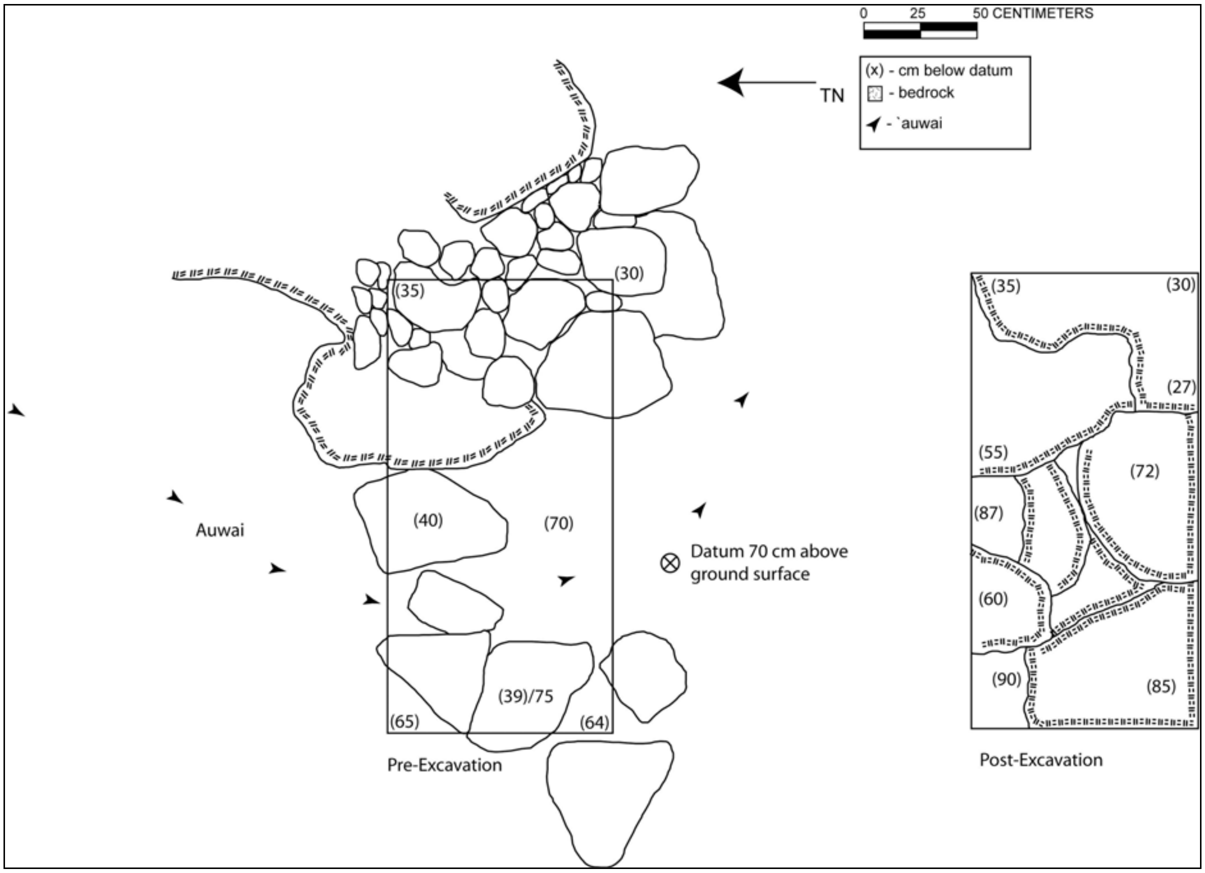

Figure 27. SIHP site -969 pre-excavation and post-excavation of trench 2

Figure 28. SIHP site -969 trench 2 base of excavation, view to the north

D. SIHP Site -973

SIHP #	50-30-10-973 (Figures 29-30)
Function:	Agriculture
Site Type:	*'Auwai*
Total Features:	1
Dimensions:	.9 m by 120 m

Description: Historic property -973 is a well-preserved pre-contact *'auwai* which is traceable for 120 m in a north/south direction. It is defined by rocky parallel mounds with a .9 m channel in the center. This *'auwai* enters SIHP site 966, an agricultural enclosure, from the north and runs along the west side of the site parallel to the west enclosing wall. A branch of this *'auwai* runs downslope (east) to the north of SIHP site -911 and feeds fields within SIHP site -966. This *'auwai* is well-preserved throughout its intact portion and extends *makai* outside the project area for 195 m to within 60 m of Po'ipū Road. This is clearly a major *'auwai* of the pre-contact field system and may have extended a significant length through the center of the project area before bulldozing occurred. It is a definite pre-contact site and the *mauka* end may have been used in historic times for sugar irrigation.

No cultural materials were observed on the surface of the *'auwai*.

1. Trench 1

Trench 1 (Figures 31-32) of SIHP site -973 was 1 m by 5 m and oriented to 345 degrees true north with the length of the trench running east/west (Figure 29). The trench was placed here to bisect the southern portion of the *'auwai* channel in order to achieve a good profile of the *'auwai*. Trench 1 cuts through both eastern and western walls of the *'auwai*.

The surface of Trench 1 was uneven with a low dip in the middle of surface from the *'auwai* channel. Large cobbles and small boulders were exposed on the surface on the east and west ends of the trench and appeared to be the eastern and western walls of the *'auwai* channel. Vegetation consisted of thick grass and *haole koa*.

Some of the small boulders and large cobbles of the eastern and western side of the channel were removed from the surface and from stratum I. However, small boulders and large cobbles did appear to be set through stratum I into stratum II. The interior channel measured 1.7 m in width.

Stratum I was an alluvial soil composed of decomposed organic material such as dead branches, leaves, and roots. This stratum ranged from 0 cm below datum to a maximum depth of 52 cm below datum.

Stratum II was comprised of a dry and loose sterile soil that extended sub-surface beyond the eastern and western walls of the *'auwai* channel. Stratum II was approximately 30 cm in thickness throughout the trench.

Stratum III was sterile, level, and had very little soil. The stratum measured approximately two to five cm in thickness and was encountered throughout the entire trench. Stratum III ended at bedrock at 106 cm below datum.

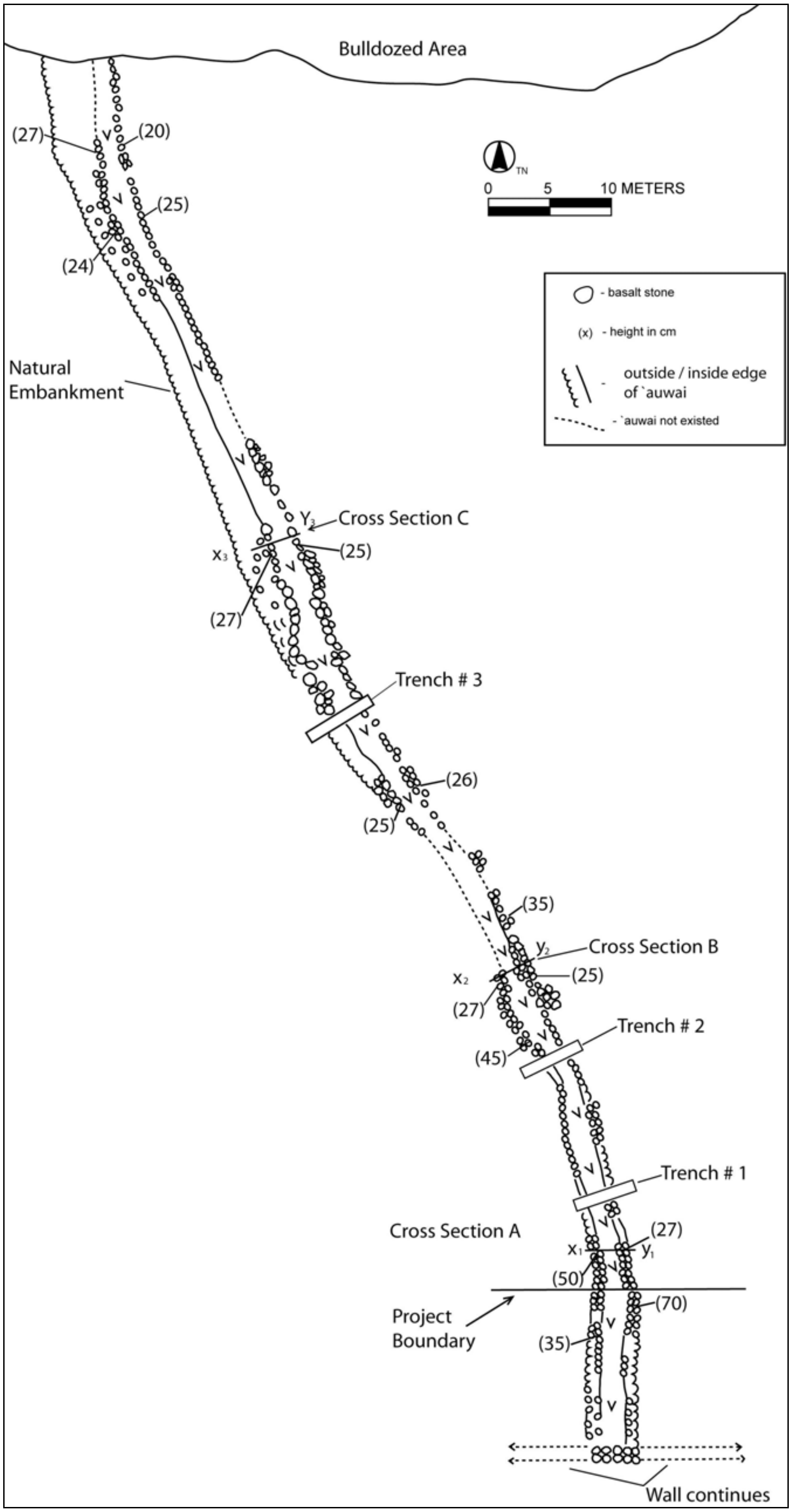

Figure 29. SIHP site -973 plan view

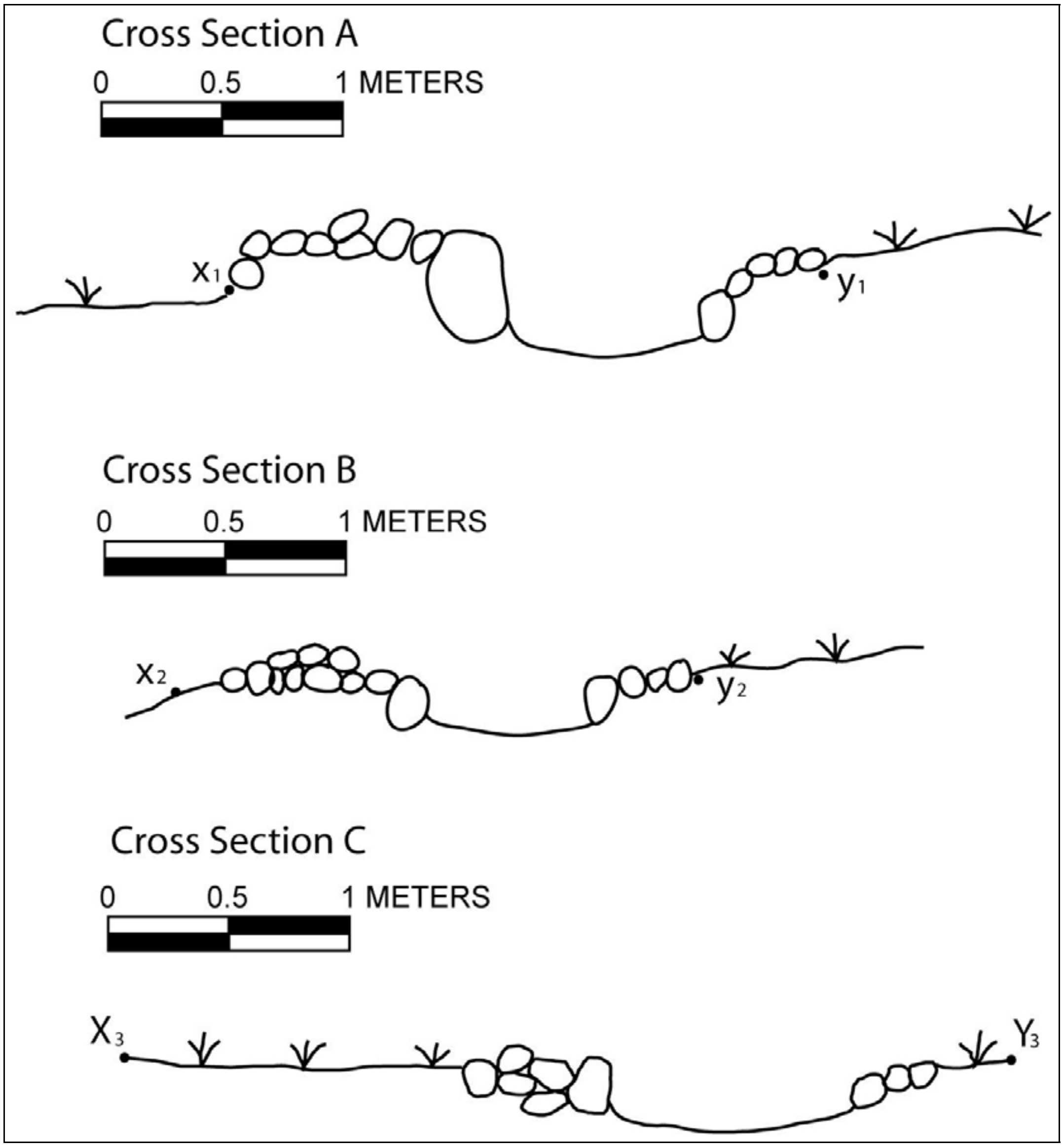

Figure 30. SIHP site -973 cross sections

No defined outline of the *'auwai* channel could be identified in the trench walls. Stratum II appeared to be continuous, extending sub-surface beyond the eastern and western wall of the *'auwai*, however, large cobbles and small boulders did appear to be set into stratum II on both the eastern and western sides of the channel.

Trench 1 Stratigraphy

Stratum I	55-60 cmbd	Soil Horizon A; 10 YR 3/1, very dark gray; medium, silt loam; weak, medium, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, wavy; none; top decomposed organic matter, soil, many small grass rootlets in I
Stratum II	60-80 cmbd	Soil Horizon B; 10 YR 3/4, dark yellowish brown; medium, silt loam; weak, medium, single grain; dry, dry weakly coherent; moist very friable; wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, wavy; cultural occupational stratum of *'auwai* extends out of *'auwai*
Stratum III	80-100 cmbd	Soil Horizon C; mottled between 10 YR 5/1 gray and 10 YR 4/3 brown; coarse, gravel, decomposed bedrock; strong, coarse, blocky; dry, dry very hard, moist very firm, wet non-sticky; non-plastic; strong cementation; terrestrial; abrupt, wavy; III consists of small gravel and decomposed bedrock

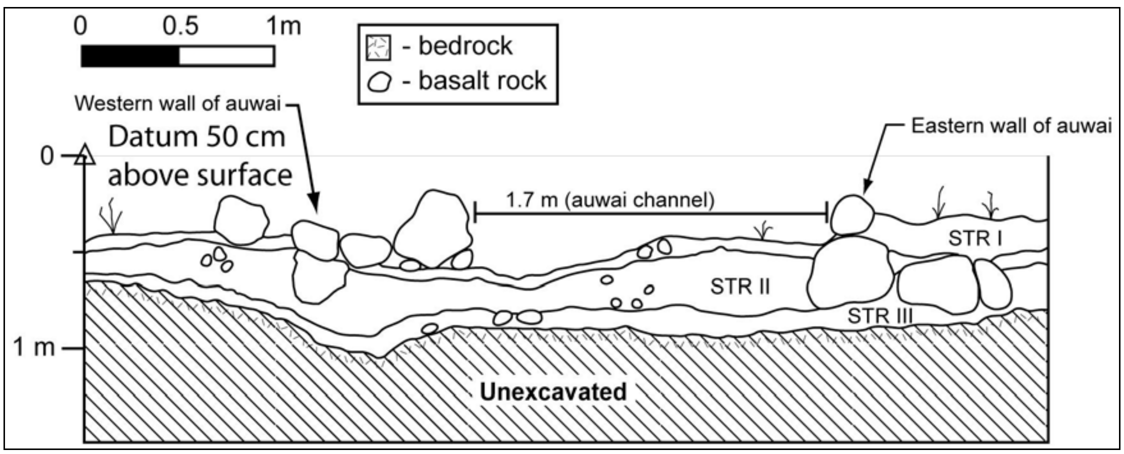

Figure 31. SIHP site -973 trench 1 north wall profile

Figure 32. SIHP site -973 trench 1 base of excavation, view to the east

2. Trench 2

Trench 2 (Figure 33-34) of SIHP site -973 was a 1 m by 5 m trench oriented 335 degrees true north with the length of the trench running east/west. The trench was placed here to bisect the middle portion of the *‘auwai* channel and also to bisect both the southern and northern walls (Figure 29). This allowed for a good profile of the entire channel while including the southern and northern walls.

The ground surface of trench 2 was fairly level with a small depression in the middle portion of the trench, being part of the *‘auwai* channel. Small boulders and large cobbles were exposed on the surface on the east and west ends of the depression and appeared to be the eastern and western walls of the *‘auwai* channel. Vegetation on the surface included very thick buffalo grass, *haole koa* trees, and unidentified weeds.

Stratum I was an alluvial soil composed of decomposed organic material and loose, mulched soil. Many small rootlets were encountered within the stratum, which ranged from a depth of 50 cm to 65 cm below datum.

Stratum II was dry, loose, sterile soil and was very shallow and almost non-existent in the middle of the trench. Stratum II ranged from 1 cm to 20 cm in thickness for a maximum depth of 73 cm below datum. Stratum II was not observed in the eastern middle portion of the *‘auwai* channel. At the eastern wall, stratum I ended on top of stratum III, which was bedrock.

Stratum III was a sterile level ranging between two and five cm thick. Stratum III surface was rocky and uneven with a slight 10-degree slope to the east/west, and comprised of loose crumb soil mixed in between and on top of bedrock cracks.

Trench 2 Stratigraphy

Stratum I	50-65 cmbd	Soil Horizon A; 10 YR 3/1, very dark gray; medium, silt loam; weak, medium, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, wavy; top organic/decomposed organic matter
Stratum II	65-75 cmbd	Soil Horizon B; 10 YR 3/4, dark yellowish brown; medium, silt loam; weak, medium, single grain; dry, dry weakly coherent, moist very friable, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, wavy; very shallow
Stratum III	75-80 cmbd	Soil Horizon C; mottled between 10YR 5/1 gray and 10Y 4/3 brown; very coarse, gravel, bedrock; strong, coarse, blocky; dry, dry very hard, moist very firm, wet non-sticky, non-plastic; strong cementation; terrestrial; abrupt, wavy; bottom of excavation, bedrock, very shallow

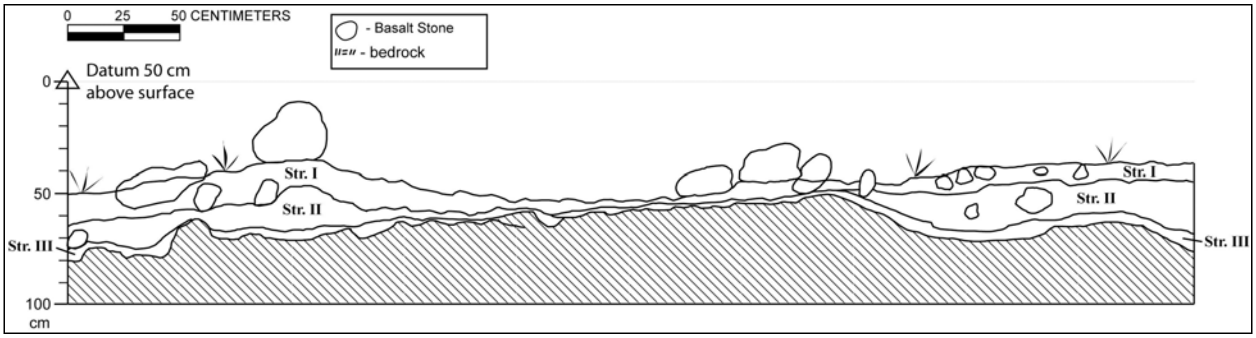

Figure 33. SIHP site -973 trench 2 north wall profile

Figure 34. SIHP site -973 trench 2 base of excavation, view to the east

3. Trench 3

Trench 3 (Figure 35-36) of SIHP site -973, a 1 m by 6 m trench, was oriented 338 degrees true north with the length of the trench running east/west. The trench was placed here to bisect the northern portion of the *'auwai* channel and to cut through both the eastern and western walls of the *'auwai* channel.

Much like trenches 1 and 2, the surface of trench 3 was rocky and uneven with a low dip in the middle of the trench surface, from the *'auwai* channel. Large cobbles and small boulders were exposed at the surface on the east and west ends of the trench which appeared to be the eastern and western walls of the *'auwai* channel. Vegetation on the surface included thick grass, *haole koa*, and unidentified weeds.

Stratum I was an alluvial soil that comprised of decomposed organic matter and loose, mulched soil containing many small rootlets. This stratum ranged from 20 cm below datum to 60 cm below datum with an average thickness of 10 to 20 cm.

The surface of stratum II was very rocky in the western half of the trench with the eastern half fairly level and cleared of stones.

Stratum II was a dry, loose, sterile soil extending sub-surface beyond both the east and west walls of the *'auwai* channel. Stratum II was approximately 20 to 30 cm in thickness throughout the majority of the trench and ended at Stratum III 80 cm below datum.

Stratum III was sterile soil mottled with decomposed bedrock. The stratum was approximately five to twenty cm in thickness and was encountered throughout the entire trench. Stratum III ended at 90 cm below datum.

Trench 3 Stratigraphy

Stratum I	55-60 cmbd	Soil Horizon A; 10YR 3/1, very dark gray; medium, silt loam; weak, medium, single grain; dry, dry loose, moist loose, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, wavy; top organic/decomposed organic soil, many small rootlets
Stratum II	60-75 cmbd	Soil Horizon B; 10YR ¾ dark yellowish brown; medium, silt loam; weak, medium, single grain; dry, dry weakly coherent, moist very friable, wet non-sticky; non-plastic; no cementation; terrestrial; abrupt, wavy; cultural occupational stratum of *'auwai*, extends out of *'auwai*
Stratum III	75-85 cmbd	Soil Horizon C; mottled between 10YR 5/1 gray and 10YR 4/3 brown and 2.5YR 2/3 dark reddish brown; very coarse, gravel, bedrock; strong, coarse, blocky; dry, dry very hard, moist very firm, wet non-sticky; non-plastic; strong cementation; terrestrial; abrupt, wavy; III small gravel mixed with sterile soil ends on top of bedrock

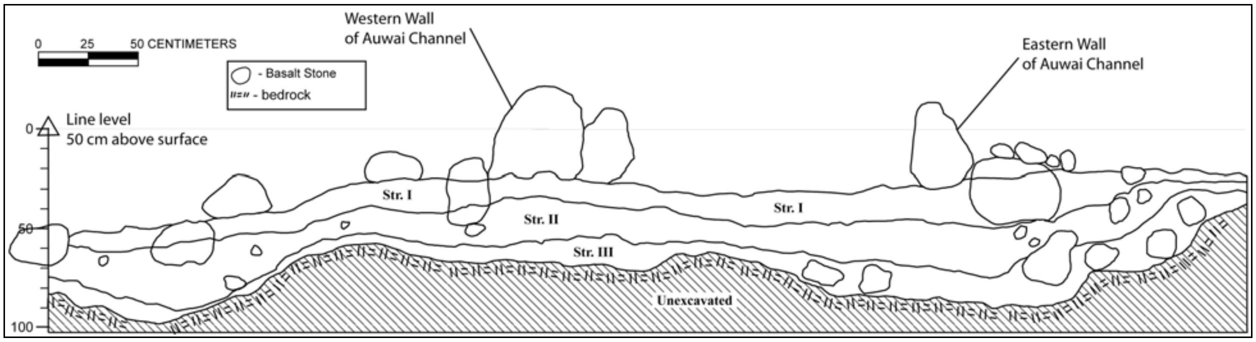

Figure 35. SIHP site -973 trench 3 north wall profile

Figure 36. SIHP site -973 trench 3 base of excavation, view to the east

VI. SUMMARY AND INTERPRETATION

A. Summary

Four sites were excavated and mapped during the course of the data recovery project. Three of the sites were excavated by hand, with the fourth (SIHP site -973) excavated by backhoe. All mapping was done by tape and compass. Screening of SIHP sites -908, -909, and 969 was done using 1/8-inch mesh.

In total, an area of 4 m^3 was hand excavated and screened within SIHP site -908. Within SIHP site -909 a total of two trenches amounting to a total combined area of 6 m^3 was hand excavated and screened. SIHP site -969 had two trenches amounting to a total combined area of 4 m^3, which was hand excavated and screened. SIHP site -973 had a total of three trenches that were excavated by the use of backhoe. The combined area for all three trenches within SIHP site -973 totals 16 m^3.

Testing in SIHP site -908 produced a limited amount of artifacts, midden and charcoal. A total of 3.8 g of midden, one basalt flake, and a few pieces of charcoal were recovered during excavation. Such a small amount of cultural material suggests that the site was used temporarily, and not for an extended period of time.

No cultural materials were observed during the testing of SIHP site -909. The lack of cultural materials suggests that this site was used temporarily and not for an extended period of time. Testing also showed that the stepped terrace was a two level natural outcrop prior to being modified into a stepped terrace, and that the stepped terrace incorporated the outcrop within its structure.

No cultural materials were encountered during the testing of SIHP sites -969 and -973, which is not uncommon for *'auwai* features. Despite the lack of charcoal, the construction of the *'auwai* sites suggests they were constructed and utilized during pre-contact times It also appears, from its stratigraphy, that both sites were constructed over stratum II, since the eastern and western walls were untraceable within that stratum.

B. Chronology

The data recovery excavations in the Phase One project area produced three datable charcoal samples (Table 4). All three of these samples were taken from SIHP site -908 and sent to Beta Analytic Inc. for radiocarbon dating analysis. No historical artifacts were recovered during the project.

The dates received from radiocarbon dating indicate that SIHP site -908 was used during late pre-contact and early historic times. The traditional construction of the site and lack of historic artifacts support the theory that the site was constructed and utilized during pre-contact times.

C. Origin and Development of Irrigated Agriculture in Kōloa

Backhoe trenching and hand excavation occurred in SIHP sites -969 and -973 in hopes to answer the question as to whether or not the development of the field systems occurred over a considerable span of time and if a certain amount of evolution of design and configuration took place. Stratigraphy from SIHP sites -969 and -973 show no evidence of secondary construction.

Table 4. Charcoal samples submitted for radiocarbon dating

Beta Analytic Lab. No.	Provenience of Sample	Measured 14 C Age (B.P.)	13C/12C Ratio	Conventional 14C Age (B.P.)	Two Sigma Calibrated Age Range (95% probability)
Beta - 196314	50-30-10-908 TU1; Stratum I	200 +/- 70 B.P.	-26.2%	180 +/- 70 B.P.	AD 1530-1560 AD 1630-1950
Beta - 196314	50-30-10-908 TU1; 90 cmbs depth; Stratum II	160 +/- 80 B.P.	-24.5%	170 +/- 80 B.P.	AD 1520-1580 AD 1630-1960
Beta - 196316	50-30-10-908 TU1; 85 cmbs depth; Stratum II	230 +/- 50 B.P.	-24.2%	240 +/- 50 B.P.	AD 1520-1590 AD 1620-1680 AD 1730-1810 AD 1930-1950

D. Post Contact Acculturation and Economic Change

No modifications of the agricultural system to produce cash crops for the merchant ship trade centered from Kōloa Landing from the mid-19th Century could be seen from the testing of sites within our current project area.

E. Coordination with Other On-going Projects

Based on data collected during the nearby work on the Kōloa Field System in Kōloa Ahupuaʻa over the past 28 years (Hammatt et al. 1996; Hammatt et al. 1976) and dates from Archaeological Research Center Hawaiʻi data, along with the current project and other previous archaeological work with dates, a general model of land settlement and agricultural adaptation has been revised in some areas to better represent the development of irrigated agriculture in Kōloa (see Table 5). The 69 radiocarbon dates in this table were all run through the most recent Oxcal system to get the time period of highest confidence for consistency, and may differ somewhat from tables in previous reports. The first column shows the date range with the greatest percentage of confidence of the portion of dates within 95.4% confidence factor, followed by other dates produced by the sample. The second column shows the feature number and the third column describes the feature type. The fourth column lists the project area of the feature. Columns 5 and 6 are the Beta Analytic sample number and the C-13 Adjusted Date. Because of cane burning, the hydrogen bomb, and perhaps other factors, many samples show a modern date range, or a span into the modern time.

Although there are samples from field walls, agricultural terraces and *ʻauwai*, the majority of features represent habitations. However, because these features are dispersed among the field system, and are an integral part of it, they can be used to infer the date of the surrounding field system.

1. Chronology of Settlement Based on Carbon Samples from Nearby Projects

Radiocarbon dates for nearby Kīahuna and Kukuiʻula provide the evidence for the basic chronology of the Kōloa Field System. The preponderance of dates is from the A.D. 1400 to 1650 period, and shows that the area was intensified later by in-filling, rather than outward expansion, from east to west.

No archaeological features in Kōloa represent the Colonization Period (from A.D. 200 to around A.D. 600), although fishing settlements, such as Keoneloa, may have been present.

Our initial view of the scanty record of settlement on the Kōloa plains during the developmental period (A.D. 600-1400) has been revised due to the introduction of ten radiocarbon dates from six archaeological features. While these dates indicate settlement was still sparse and isolated as posited earlier, we now have verification of habitation terraces and lava tubes from this period. The radiocarbon dates for these six features comprise a timeframe of approximately 100 years though several samples from the same sites did produce the same results. Each of these features may represent recurrent, if not permanent, habitation, probably in association with both wetland (based on only 1 sample of a wetland feature) and dry land (based on lava tubes away from Waikomo Stream area) agriculture just before or around A.D. 1000. *mauka* of the shore, and most unexpectedly, in nearby project areas of Kīahuna, and Kukuʻiula. A radiocarbon sample from a habitation platform (2A) in the nearby Kīahuna project produced date ranges between A.D. 890-1060 and A.D. 1070-1160 (ARCH data); a ponded field (3A) in the same project produced a date between A.D. 1290-1450. In the nearby Kukuiʻula Phase II project an enclosed terrace (1906B) produced a radiocarbon sample date range of A.D. 1280-1410; a nearby habitation platform (1906A) obtained dates ranging from A.D. 1250-1410 and A.D. 1260-1410; and a field mound obtained dates between the period A.D. 1260-1400 (1944A).

In the middle of this period, from A.D. 890-1400, Hawaiians established intermittent habitations in Kōloa lava tubes. Numerous caves are known in the Kōloa vicinity (The Honolulu Advertiser 7/4/99:A17,A21), and, at least ten caves were found in a 1978 reconnaissance survey (Hammatt et al. 1978) of the Kīahuna area. Furthermore, two caves were located in the nearby Kukuiʻula Phase I project area, and recently a cave was discovered near Kōloa Town during bulldozing for a road. Two caves - one in Kīahuna (Cave 267) and one in the Kukuiʻula Phase I project area (SIHP site 1927A) - provided two radiocarbon samples with a date range of A.D. 1260-1400. These and other caves were occupied continuously from this period onward.

To the east of the *ahupuaʻa* of Kōloa at Keoneloa, in Paʻa, Hammatt and Toenjes (1991) and Walker and Rosendahl (1990) obtained shoreline samples with some dates within this time range. We surmise that Kukuiʻula Bay and the outlet of Waikomo Stream may have had fishing villages before A.D. 1400, but we have no archaeological evidence.

In summary, in the period A.D. 1250 to 1450 there are ten radiocarbon dates for seven features that include two lava tubes, two habitation terraces and one *loʻi*.

Table 5. Dates, feature types and project names for Kōloa Ahupuaʻa

DATES	SITE #	FEATURE TYPE	PROJECT	BETA #	C13 ADJUSTED
0890-1060*, 1070-1160	2A	lava tube	Kīahuna	31867	1020+/-50BP
0950-1700	1927A	lava tube	Kukuiʻula I	41819	640+/-190BP
1020-1310*, 1350-1390	267	lava tube	Kīahuna	37082	800+/-90BP
1250-1410	1906A	habitation terrace	Kukuiʻula II	116887	670+/-50BP
1260-1400	1927A	lava tube	Kukuiʻula I	41808	670+/-50BP
1260-1410	1906A	habitation terrace	Kukuiʻula II	116886	640+/-60BP
1270-1440	267	lava tube	Kīahuna	37087	590+/-70BP
1280-1410	1906B	habitation terrace	Kukuiʻula II	116884	620+/-50BP
1280-1450	1906B	habitation terrace	Kukuiʻula II	116885	560+/-70BP
1290-1450	3A	Loʻi	Kīahuna	31866	530+/-50BP
1400-1530*, 1550-1640	1905A	habitation platform	Kukuiʻula II	116881	420+/-50BP
1400-1650	1927C	field wall	Kukuiʻula I	41818	410+/-70BP
1400-1660	1803B	habitation platform	Kukuiʻula I	41802	390+/-80BP
1410-1640	1943D	auwai	Kukuiʻula I	47961	410+/-60BP
1410-1690*, 1730-1810	267	lava tube	Kīahuna	37081	330+/-90BP
1430-1680*, 1750-1800	1909A	enclosure, ag.	Kukuiʻula II	116891	320+/-70BP
1440-1640	1906B	habitation terrace	Kukuiʻula II	116883	370+/-50BP
1440-1640	267	lava tube	Kīahuna	37084	360+/-50BP
1440-1650	1943D	auwai	Kukuiʻula I	47960	350+/-60BP
1440-1650	304	lava tube	Kīahuna	31870	360+/-60BP
1440-1690*, 1730-1810	267	lava tube	Kīahuna	37086	290+/-70BP
1440-1700*, 1730-1820, 1920…	1930B	mod. outcrop	Kukuiʻula I	41806	280+/-70BP
1450-1670	1951D	habitation platform	Kukuiʻula I	41800	310+/-50BP
1450-1690*, 1740-1810	1944A	habitation platform	Kukuiʻula I	41821	280+/-60BP
1450-1700*, 1720-1830, 1920…, 1840-1880	1929D	enclosure	Kukuiʻula I	47959	260+/-70BP
1460-1700*, 1720-1820, 1920…	267	lava tube	Kīahuna	37080	260+/-60BP
1460-1700*, 1720-1820, 1920…	1928A	sink hearth	Kukuiʻula I	41811	260+/-60BP
1460-1700*, 1720-1820, 1920…	1927A	lava tube	Kukuiʻula I	41807	260+/-60BP

DATES	SITE #	FEATURE TYPE	PROJECT	BETA #	C13 ADJUSTED
1470-1680*, 1730-1810	1946F	habitation enclosure	Kukuiʻula I	41794	270+/-50BP
1470-1890*, 1910…	1944	field wall	Kukuiʻula I	41804	240+/-70BP
1480-1700*, 1720-1820, 1920…	1938E	habitation terrace	Kukuiʻula I	41803	240+/-50BP
1490-1710*, 1720-1890, 1910…	1941D	C-shape	Kukuiʻula I	49065	230+/-60BP
1490-1710*, 1720-1890, 1910…	1003	habitation platform	Kīahuna	37089	230+/-60BP
1510-1700*, 1720-1830, 1910…, 1840-1880	1951A	C-shape	Kukuiʻula I	41796	230+/-50BP
1510-1700*, 1720-1830, 1910…, 1840-1880	1003	habitation platform	Kīahuna	37088	230+/-50BP
1510-1890*, 1910…	1927C	field wall	Kukuiʻula I	41816	220+/-60BP
1610-…*, 1510-1600	1944B	habitation platform	Kukuiʻula I	41805	210+/-70BP
1620-…*, 1520-1570	1927C	field wall	Kukuiʻula I	41817	200+/-60BP
1620-1960*, 1520-1590	908	habitation platform	Current Project	196314	200+/-70BP
1630-1890*, 1910…, 1530-1550	267	lava tube	Kīahuna	37085	200+/-50BP
1630-1960*, 1520-1550	908	Habitation platform	Current Project	196315	160+/-80BP
1635-…*, 1531-1548	1951D	habitation platform	Kukuiʻula I	41801	190+/-60BP
1646…	1927C	field wall	Kukuiʻula I	41815	140+/-80BP
1650…	1930A	heiau	Kukuiʻula I	41813	160+/-50BP
1650…	246	habitation platform	Kīahuna	37079	160+/-60BP
1660…	297	C-shape	Kīahuna	31869	150+/-60BP
1662…	246	habitation platform	Kīahuna	37078	140+/-70BP
1700-1740*, 1870-1920, 1820-1840	1947F	agric. terraces	Kukuiʻula I	41824	100.8+/-.8BP
1700-1740*, 1880-1920, 1820-1840	1927C	field wall	Kukuiʻula I	41825	100+/-1BP
1720-1820*, 1610-1700	908	habitation platform	Current Project	196316	230+/-50BP
1790…*, 1660-1780	260	artifact scatter	Kīahuna	31868	125+/-50BP
1790…*, 1660-1780	1930A	heiau	Kukuiʻula I	41814	100+/-1BP
1795-…*, 1670-1755	1951D	habitation platform	Kukuiʻula I	41798	60+/-60BP

DATES	SITE #	FEATURE TYPE	PROJECT	BETA #	C13 ADJUSTED
1795-…*, 1670-1760	1947G	habitation enclosure	Kukuiʻula I	41795	70+/-60BP
1795-…*, 1670-1770	1945	field wall	Kukuiʻula I	41822	80+/-60BP
1795-…*, 1670-1770	1909B	auwai	Kukuiʻula II	116892	110+/-50BP
1795-…*, 1670-1765	1927A	lava tube	Kukuiʻula I	41809	100+/-50BP
1795-…*, 1670-1770	1928A	sink hearth	Kukuiʻula I	41812	110+/-50BP
1795-…*, 1670-1770	1927A	lava tube	Kukuiʻula I	41810	80+/-60BP
1800-1930*, 1680-1740	267	lava tube	Kīahuna	37083	10+/-50BP
1800-1940*, 1670-1750	1938F	habitation platform	Kukuiʻula I	47958	70+/-50BP
1800-1940*, 1670-1750	1905B	habitation platform	Kukuiʻula II	116882	70+/-50BP
1800-1940*, 1680-1750	1927C	field wall	Kukuiʻula I	41820	20+/-60BP
1800-1940*, 1680-1750	1951D	habitation platform	Kukuiʻula I	41799	60+/-50BP
1800-1940*, 1680-1750	1951D	habitation platform	Kukuiʻula I	41797	60+/-50BP
1800…*, 1675-1750	1909A	enclosure, ag.	Kukuiʻula II	116890	50+/-60BP
1800…*, 1675-1750	1907B	habitation platform	Kukuiʻula II	116888	50+/-60BP
1800…*, 1675-1750	1907B	habitation platform	Kukuiʻula II	116889	80+/-50BP
modern	361	C-shape	Kīahuna	31871	modern

*highest rate of confidence within 95.4%

In CSH earlier reports, we saw the beginning of the Kōloa field system during the Expansion Period (A.D. 1400-1650). The archaeological evidence now seems to further substantiate this proposition. Thirty-five percent of the radiocarbon dates, represented in all project areas mentioned above, fall within the 1400s, and another 12% fall between A.D. 1500 and 1650. Of the dates with highest confidence either ending or beginning in the 1400s and spanning up to A.D. 1710, we have 31 radiocarbon dates for 21 features (45% of the total 69 dates obtained). The 21 features include 9 habitation platforms, terraces and enclosures, 2 lava tubes and a sink, 2 field walls, 1 *ʻauwai*, 2 agricultural enclosures, 2 C-shapes, and a modified outcrop. Within the Kōloa Field System, this period truly exemplifies a period of expansion.

Because Fornander attributes the execution of irrigation systems on Kauaʻi to Manokalanipo-a-Kauaʻi, we posit the theory that Manokalanipo formally expanded the small, cultivated patches along Waikomo Stream (and perhaps other small stream areas nearer the Weliweli boundary) into an irrigated field system from east to west boundaries in Kōloa.

According to Hommon (1976:133, 304), Manokalanipo probably ruled Kaua‘i during the fifteenth century, in the A.D. 1490 to 1510 time frame. Manokalanipo “was noted for the energy and wisdom with which he encouraged agriculture and industry, executed long and difficult works of irrigation, and thus brought fields of wilderness under cultivation. No foreign wars disturbed his reign, and it is remembered in the legends as the golden age of that island (Fornander vol. 2, 1969:93).” F.B. Wichman (1998:102) dates Manokalanipo slightly earlier, in the fourteenth century, but does not give his source of information. However, 40% of the known radiocarbon dates obtained so far in Kōloa from east to west boundaries are from the end of the fifteenth century and would therefore support the hypothesis that Manokalanipo was the administrator of this field system. This conclusion would indicate that the irrigation system that had probably existed near Waikomo Stream was channelled throughout the lower reaches of the *ahupua‘a* within a short period of time. Since his reign was known to be without wars, Manokalanipo would have had ample time and manpower to devote to such a project.

Earlier dates have been obtained to the east of the *ahupua‘a* of Kōloa (Walker and Rosendahl 1990), which suggest that the population was more concentrated east of Kōloa. Based on our present collection of radiocarbon dates from both habitation and agricultural features, it appears that there is sufficient dating to suggest that a field system with dispersed habitation throughout the *makai* part of the *ahupua‘a* from east to west was basically in place during the fifteenth century.

Long *‘auwai* were constructed along the tops of topographic high points formed by northeast to southwest oriented Kōloa lava flows and ran all the way to the sea. The earliest dates for an *‘auwai* was for one close to Waikomo Stream (1943D) (A.D. 1410-1640 and A.D. 1449-1650), but a field or *lo‘i* wall (SIHP site -1927C) in the northwest portion of the nearby Phase I Kukui‘ula project area, almost one mile west of Waikomo Stream, appears to have existed contemporaneously (A.D. 1400-1530 and A.D. 1400-1650). This would indicate a fairly unified effort in the laying out of the entire system. This site is near a habitation cave with a possibly much earlier date that appears to have been used over several centuries. On the other hand, a radiocarbon date from the *‘auwai* (1909B) in the Phase II Data Recovery project of Kukui‘ula, which was inland but approximately the same distance from Waikomo Stream as the earlier 1943D *‘auwai*, appears (using the highest confidence date range) to date to the end of the eighteenth or into the nineteenth century. This later date suggests that the field system was still in use during the early visiting western ships and during the whaling period and that new *‘auwai* were still being constructed.

In summary, the majority of the dates in this time range represent habitations, in part because more datable samples of sufficient size were found in these features. Habitation sites included small house platforms, enclosures and shelters built on rocky bluff areas occupying high points in the landscape and at *‘auwai* junctions. Since these habitations were dispersed within the field system, we infer that surrounding agricultural fields were cultivated simultaneously with the inhabited features.

Almost all of the seventeenth and eighteenth century radiocarbon dates we obtained extend into the present but include the same types of structures found earlier. The *heiau* (site -1930) appears to have been built within this Proto-Historic Period (A. D. 1650-1795). Twenty-three percent of the Kōloa Field System radiocarbon dated belong to this time frame, which suggests that there was continued improvement and building of features during this period, though the main network was already laid out. Subsequent habitations and *‘auwai* and field walls were filled in where necessary to accommodate lands lying fallow (as suggested in our research goals) and intensification of land use.

Features dating to the second half of the seventeenth and to the eighteenth century, include the following site types: three habitation platforms and one habitation terrace, one lava tube and one sink hearth, two field walls, one *'auwai*, one set of agricultural terraces, one C-shape, an artifact scatter and the *heiau* (2 dates). These represent sites scattered among the older sites already discussed.

All of the A.D. 1795 radiocarbon sample dates extend into the present. This Historic Era Period (A.D. 1795 - 1880) is represented by seven radiocarbon samples, including a sample from a lava tube and a C-shape in Kīahuna; a lava tube, a lava sink hearth, four habitation platforms, and a field wall in the nearby Kukuiʻula Phase I area; and an *'auwai*, two habitation platforms, and an agricultural enclosure from Phase II of nearby Kukuiʻula. After A.D. 1800 there are nine radiocarbon samples representing a lava tube and a C-shape in nearby Kīahuna, three habitation platforms and a field wall in the nearby Kukuiʻula Phase I area and three habitation platforms and an agricultural enclosure in nearby Kukuiʻula Phase II area. Plentiful Euro-American trade items were found at two residential structures in the Phase I area. The site types in the A.D. 1800-1900 period comprise 1 sample from the lava tube already shown to have been in use prior to the historic period, multiple dates from four habitation platforms, a field wall, one C-shape, and one agricultural enclosure.

It was first hypothesized in the nearby Kīahuna study that settlement in Kōloa was dispersed rather than concentrated due to the critical need for irrigated land (Hammatt et al. 1978:40). The evidence of habitation structures at *'auwai* branches and gates reflected the primary importance of water control in the economy and in the minds of the people while the small enclosures and C-shaped structures throughout the field system indicated the constant care of plants and maintenance of *'auwai* and *lo'i* (Op. cit.: 53). Based on all project areas described, this hypothesis of dispersed settlement appears to remain intact throughout the entire Kōloa Field System, including the current project area.

F. Artifact and Midden Analysis

During the course of the data recovery, only one artifact was found (Figure 37). This artifact, a basalt flake, measuring 4 ¼ by 1 ½ by ¾ cm and weighing 5.9 g, was found 80 cm below datum in trench 1 of SIHP site -908. Due to the fact that this basalt flake was the only artifact recovered, no analysis of artifacts is warranted.

Similar to the artifacts, a very limited amount of midden was recovered during the course of the data recovery, making it impractical to do a midden analysis. In total, 3.8 g of midden was recovered from stratum I in trench one located on SIHP site -908. Marine invertebrates accounted for 100 percent of midden recovered which is fairly typical for Kōloa. Of the midden recovered, 2.2 g was of *Conus* species, 0.8 g was *Periglypta reticulata*, 0.3 g was *Nerita picea*, and 0.5 g was unidentified shell.

Figure 37. SIHP site -908, basalt flake

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Appendix I

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING, ROOM 555
601 KAMOKILA BOULEVARD
KAPOLEI, HAWAII 96707

December 15, 2004

Hal Hammatt, Ph.D.
Cultural Surveys Hawaii
P.O. Box 1114
Kailua, HI 96734

Kolo 27 FX + mailed 1/4/05

Log No: 2004.3476
Doc No: 0411NM14

Dear Dr. Hammatt:

SUBJECT: Chapter 6E-42 Historic Preservation Review - "Data Recovery Plan for the Knudsen Trust Lands Village at Po'ipu, State Site 50-30-10-947 Railroad Berm, Koloa Ahupua'a, Kona District, Kauai Island" (Esh and Hammatt, CSH, 2004)
Koloa, Kona, Kaua`i
TMK: (4) 2-8-014:019 por.

Thank you for submitting the subject data recovery plan which we received on November 15, 2004. The field work actually includes archaeological monitoring of the breaching of Site No. -947 in addition to the data recovery tasks outlined below. The railroad berm needs to be breached for a subdivision road into the proposed Village at Po`ipu Phase I project area.

The subject plan calls for the following documentation:

- Professional photographs (done to HABS standards) taken before and after the breaching of the site;
- Cross-sectional drawings;
- Historical research on the methods and context of construction;
- A brief report on the construction style of the berm;
- Stabilization and reconstruction of the cut ends in a historically appropriate manner

We believe that the subject plan is adequate, and can accept it as final. We believe that any effect on Site No. -947 due to the construction of the subdivision road will be mitigated through implementation of the subject plan.

Should you have any questions, please contact Nancy McMahon at 742-7033.

Aloha,

Melanie A. Chinen, Administrator
State Historic Preservation Division

C: Ian Costa, Director, Department of Planning, County of Kauai, 4444 Rice Street, Suite 473, Lihue, HI 96766
Chair, Kaua`i Historic Preservation Review Commission
Thomas Lim, Branch Chief, Architecture

Data Recovery Plan for the Knudsen Trust Lands

Village at Poʻipū, State Site 50-30-10-947 Railroad Berm

Kōloa Ahupuaʻa, Kona District, Kauaʻi Island

TMK 2-8-14: 19

by

Kelley S. Esh, B.A.

and

Hallett H. Hammatt Ph.D.

Prepared for
Eric A Knudsen Trust
Mr. Stacey Wong
P.O. Box 759
Kalāheo, HI 96741

by
Cultural Surveys Hawaiʻi, Inc.
September 2004

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I. INTRODUCTION

A. Project Background

This document comprises the data recovery plan for a portion of railroad berm (state site 50-30-10-947) that will be breached to allow for a proposed subdivision road in the Village at Po‘ipū Phase I project area. The railroad berm is located on TMK 2-8-14:19, owned by the Eric Knudsen Trust in Kōloa, Kaua‘i (Figures 1 and 2). Included in this document is a description of site 947 and a discussion of how data recovery should be undertaken during the course of construction activities. The purpose of this document is to provide a data recovery plan that adequately mitigates the proposed impact to site 947 and satisfies the State Historic Preservation Division’s (SHPD’s) regulations. The document will identify the historic property to be studied, identify research objectives and data needed to address those objectives, and identify the field methods that will be used to acquire and analyze collected data.

B. Methods

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division of the Department of Land and Natural Resources and a review of documents and maps at the Cultural Surveys Hawai‘i library.

C. Scope of Work and Research Goals

The research focus of this data recovery project is to gather more information about construction of the railroad berm as a section of it is being breached for an access road. The railroad berm is of historic significance, and construction methods have not been previously recorded. Demolition of a small portion of the berm will allow for documentation of its original construction. Documentation will consist of cross-sectional drawings by an archaeologist, and the production of archival quality photos of the berm.

In addition, primary historic documents will be consulted to learn more about this specific portion of the railroad. While various sources discuss the history of sugar trains on Kaua‘i, there is currently no specific date known for when the tracks in the project area were laid. A review of primary sources, such as records from the Grove Farm Company, McBryde Sugar Company, and the Kaua‘i Historical Society, may provide additional information about this portion of the sugar train railroad that has not been compiled previously.

D. Natural Setting

The project area is in the *makai* (seaward) section of the Hawaiian *ahupua‘a* (land division) of Kōloa in the *moku* (district) of Kona. This *ahupua‘a* extends as a fairly large land segment from Mt. Kāhili to the sea. It is bordered by Lāwa‘i Ahupua‘a to the west and Weliweli Ahupua‘a to the east. The project area is situated within 800 m (one-half mile) of the shoreline at an elevation of approximately ten to forty feet (3 m. to 12 m.) above mean sea level. Waikomo Stream, approximately 1.5 km to the northwest, is a perennial stream and is the primary source of surface water in Kōloa.

The land here is constructed of the lavas of the Kōloa Volcanic Series that are post-erosional lavas less than 1.5 million years old (Macdonald and Abbott 1974). These Kōloa Series flows form a broad apron of predominantly *pāhoehoe* lava beneath the project area. Rainfall averages between 30 and 40 inches a year (Armstrong 1973); prevailing winds are from the northeast, and temperatures range from about sixty to ninety degrees Fahrenheit throughout the year. This dry environment with shallow soil today supports predominantly *koa haole* (*Leucaena glauca)*, exotic grasses, and weeds.

Figure 1. Portion of U.S.G.S. map, Kōloa Quad, showing old railroad grade and project area

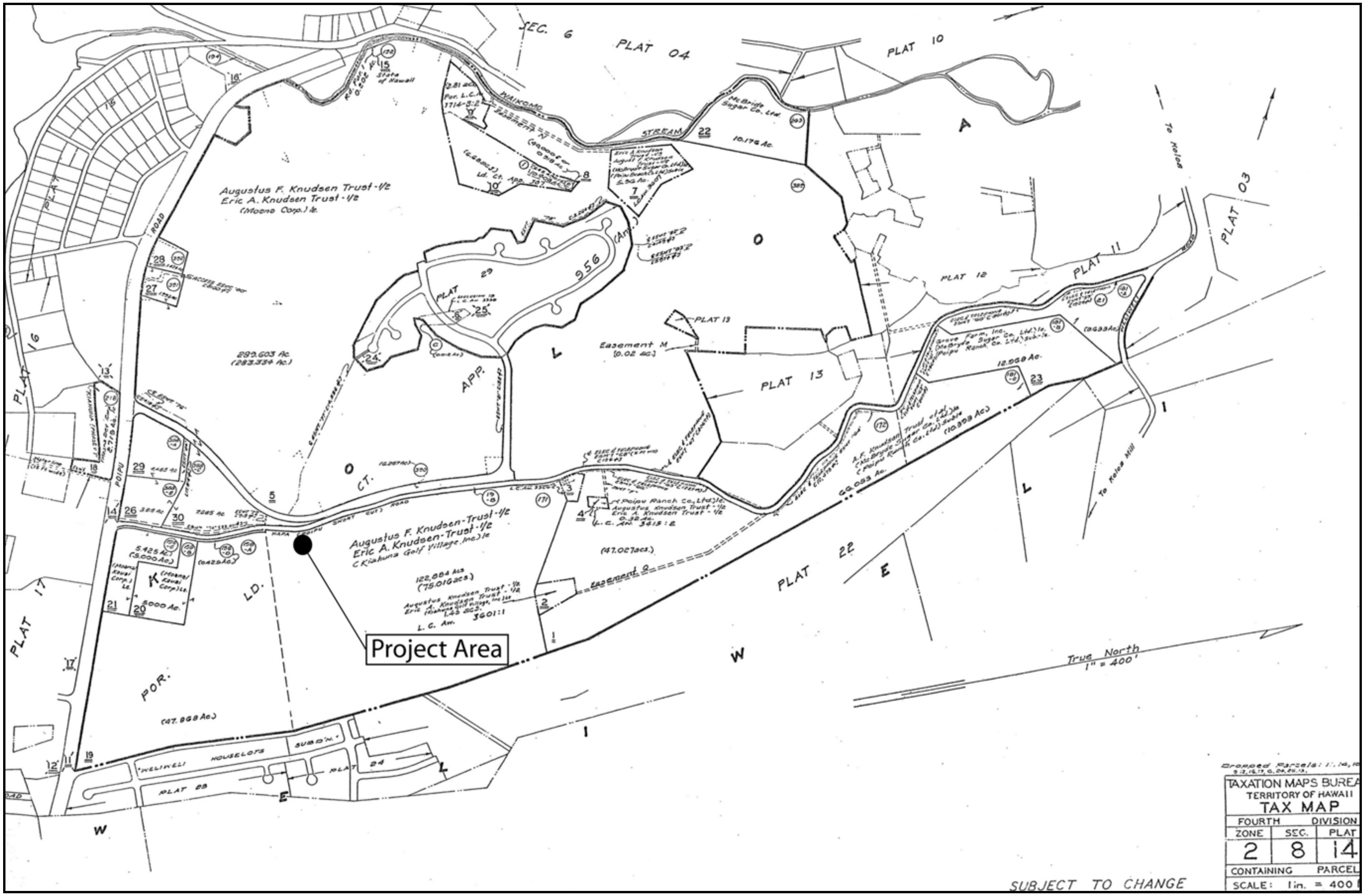

Figure 2. TMK 2-8-14 showing project area

II. HISTORICAL BACKGROUND

A. Early Historic Period to Mid-1800s

Early historical and ethnographic information suggest that Kōloa was well populated during the late pre-contact period (Cook 1818, Vancouver 1798, Judd 1935). Systematic historic records began with the founding of the American Protestant Mission at Kōloa in 1834 under the Reverend Peter Gulick. On December 31, 1834, Peter Gulick and his family arrived in Kōloa. Apparently the first foreigners to settle in the *ahupua'a,* they initiated the process of rapid change that would re-shape the life of Kōloa in the nineteenth century. In 1835, a 30 by 60 foot grass house was erected as a meeting-house and school (probably located at Kōloa Town). Mr. Gulick initiated sugar cane cultivation and collected a cattle herd for the Protestant Mission (Damon 1931). The first plowing on the Kōloa sugar plantation was done in 1836, when "a team of forty powerful natives was always needed to operate a plow" (Damon 1931: 188).

The first changes from traditional agricultural and habitation patterns began in the 1830s, when sugar mills began more intense production. From 1820 to 1832, several Chinese were involved in sugar production in small mills at Waimea, Kōloa, Māhā'ulepū, and Lāwa'i (Donohugh 2001:87). However, Ladd and Company began a commercial enterprise by 1935, and the Chinese mills went out of business. The mill and plantation operation resulted in an increase in emigration from other areas of Kaua'i, and the population was estimated around 3,000 (Damon 1931). The sugar industry became increasingly important at this time:

> Kōloa, in fact, was the most thriving center on Kaua'i during the generation from 1840-1870, and apart from its interest as a port of call, is distinguished by the fact that its sugar plantation, begun there by Ladd and Company in 1935, was the first to make Hawaiian sugar a commercial success (Damon 1931: 176).

The advent of the Ladd and Company enterprise transformed Kōloa into a commercial center, and Kōloa became the scene of the confrontation of the traditional social structure with commercially impelled forces of change. The cane growing activity of Ladd and Company would inevitably affect the lives of the inhabitants of the rest of the *ahupua'a*. Traditional settlement patterns (*e.g.* permanent and temporary habitation interspersed throughout the irrigated agricultural fields near the coastal zone and traditional farming along streams) would have been distorted by a shift to Kōloa Town where sugar cane milling activities were located, and a shift to cash crops other than taro.

Although Ladd and Company would go bankrupt in 1845, its earlier success was an impetus for other entrepreneurial attempts within Kōloa. However, none of these other agricultural ventures were too successful. Mulberry fields were started for silkworms, but wind and drought killed them off. An attempt was made to develop a commercial market for *kukui* nut oil, but this failed as well. Tapioca was manufactured from cassava root for a brief period during the 1860s, but was apparently not commercially successful (Damon 1931).

All of these agricultural ventures, along with the increasing emphasis on sugar production, led to large scale modification of the land. It is likely that fields previously used for taro production were modified for new cash crops such as sweet potatoes, and, in some cases, were abandoned or destroyed to make room for commercial crops. By 1884, most of the land at Kōloa had been given over to sugar production.

B. Kōloa Sugar Company and Railroad

Ladd and Co. incorporated as the Kōloa Sugar Company in 1880, following a succession of individual and partnership owners, and eventually (in 1948) became part of the Grove Farm Company. In 1882, the Kōloa Sugar Co. announced the construction of a railroad system, consisting of four miles of 30-inch gauge track, forty cars 50 x 210 feet, and one locomotive (Conde and Best 1973:159). The first plantation tracks were probably laid between the cane fields and the sugar mill, although there are no records as to exactly where they were laid. The exact date of the construction of the railroad berm in the current project area is thus unknown, but it was certainly between 1882 and 1910, and most likely near the turn of the century. The portion of railroad within the project area appears on a 1910 U.S.G.S. map (Figure 3) and on the 1911 Kōloa Sugar Company map (Figure 4).

As sugar production increased, new mills were built and the railroad expanded. In 1904, a three-mile addition to the Puuhi railroad and a “short-cut road” to Māhāʻulepā were added (Alexander 1937: 93, 122). By 1910, the rails extended to Kōloa Landing where the steamers transported the bags of sugar to the mainland, and thus Kōloa Landing was commercially important for the Kōloa Plantation (Donohugh 2001:106). The *San Francisco Chronicle* (1910) commented:

> Cane is transported from the fields to the mill over a railroad system that consists of fifteen miles of permanent track, two miles of portable track, 250 cane cars and track, two miles of portable track, 250 can cards and four locomotives. About two miles from the mill and connected with by rail is the steamer landing, with a warehouse that will hold 20,000 bags of sugar (cited in Conde and Best 1973:159).

Six locomotives were purchased by Kōloa Sugar Company between 1882 and 1920 (Table 1). Rail extensions continued, and in 1919 a railroad manager commented, “… by the end of December we will reach the boundary line of the Knudson Brothers and Grove Farm. Then there will be only a short distance to connect the Lihue-Grove Farm track with Kōloa” (cited in Conde and Best 1973:159). The rails were not actually joined until 1930, but sugar production had increased enough to warrant the purchase of more locomotives. In 1931, Gilmore’s *Hawaii Sugar Manual* reported on the Kōloa Plantation railroad:

> All cane is delivered to the mill by cars. The plantation railway system consists of 19.5 miles of 30 inch gauge track, also have 5.17 miles of portable track. Have 350 cane cars of 3 to 5 ton capacity, flare side door type, operated by means of three oil fired Baldwin locomotives of 18-ton, 15-ton, and 12-ton size (cited in Conde and Best 1973:159).

Kōloa Landing was phased out around 1925 when McBryde Sugar Company and Kōloa Sugar Company began using the alternate Port Allen. Soon after this the sugar companies ceased to use the *makai* Kōloa fields, and much of the area was converted into pastureland, used for cattle grazing by the Knudsen family. A map of Kōloa Plantation (Figure 5, Alexander 1937) shows the extent of the sugar cane fields in 1935. The map also shows the railroad, which extends from Kōloa Mill to Kōloa Landing.

C. Summary of Historical Background

Accounts of the early history of Kōloa (Farley 1907; Jarves 1844; Townsend 1839; Judd 1935) describe in the lands *mauka* of Kōloa Town a seemingly continuous, well-maintained, agricultural complex of taro, yams, sweet potato, and sugar cane that was irrigated by an extensive *ʻauwai* system siphoned off of Waikomo and Pōʻeleʻele streams. This system had a significant influence on later commercial endeavors in Kōloa. Kōloa is the site of the first organized sugar plantation in Hawaiʻi. Ladd and Company leased about a thousand acres for the sole purpose of growing sugar cane (Palama and Stauder 1973:18, from Judd 1935). The commercialization of sugar cane in Kōloa had widespread social effects, as the traditional view of the *ʻāina* (land) being a responsibility of the *aliʻi* (chiefs) was being transformed.

Kōloa Town, and Kōloa Landing, at the mouth of Waikomo Stream, became prominent commercial centers during the mid to late 1800's, exporting a variety of products such as sweet potatoes, sugar and molasses. Whalers stopped for provisions of squash, salt, salt beef, pigs, and cattle (Palama and Stauder 1973:20). Sugar cane production became of mounting importance during this time period. Built in 1882, the railroad was used to haul sugar from Weliweli and Paʻa to Kōloa Landing. Escalating sugar production led to the expansion of this railroad over the next 50 years, as transportation needs were increasingly important to the sugar industry. This heightened activity dramatically altered the social structure and landscape of Kōloa. Kōloa soon reflected the effects of a traditional social structure in conflict with commercially impelled forces of change. Railroad expansion continued after the acquisition of the Kōloa Plantation by the Grove Farm Co., until the railroad was finally replaced by trucking in the early 1950s (Conde and Best 1973:129). Some inland areas of Kōloa remained under sugar cane cultivation until at least as late as the 1970s, when these cane lands were converted into pasture.

Table 1. Locomotive Roster, Kōloa Sugar Company (adapted from Conde and Best 1973: 164)

Year	Name	Locomotive Type	Description
1882	Unknown	Fowler	John Fowler & Co. Leeds, England. Details not known
1887	*Paulo*	Hohenzollern 426	Built Dusseldorf, Germany. Named for Paul Isenberg, prominent early Kauai Sugar Planter
1891	*Haupu*	Hohenzollern 632	Built Dusseldorf, Germany. Scrapped after larger engines were on planatation
1897	*Puuhi*	Baldwin Locomotive Works 15565	#1. New Broiler with oil burning arrangements
1900	*Kōloa*	Baldwin Locomotive Works 18396	#2. New Broiler with oil burning arrangements
1920	*Mahaulepu*	Baldwin Locomotive Works 52875	#3. Side tanks both sides. Vernacular translation of name is "snorting rabbit"

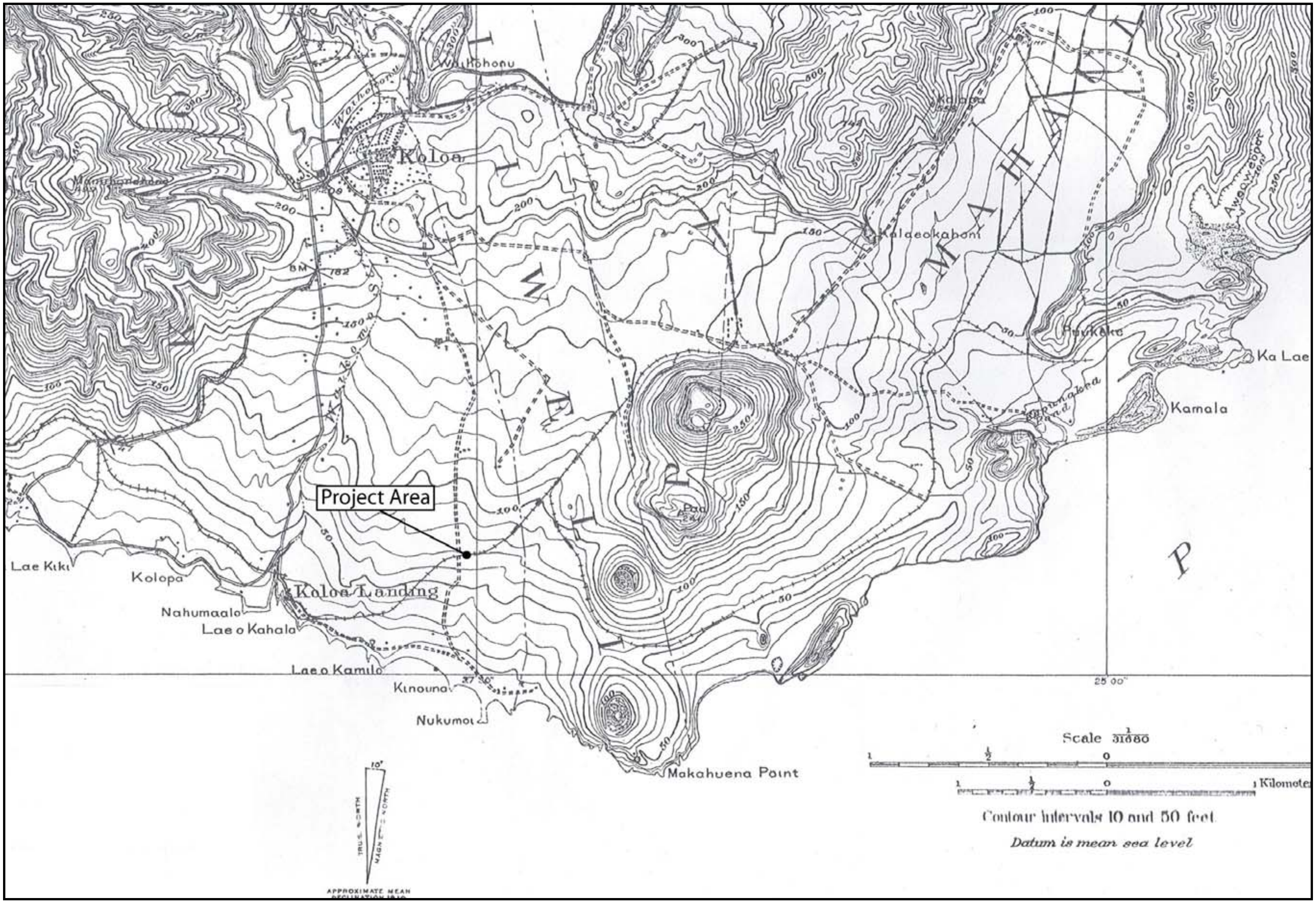

Figure 3. Portion of 1910 U.S.G.S. Map of Kauai, showing railroads

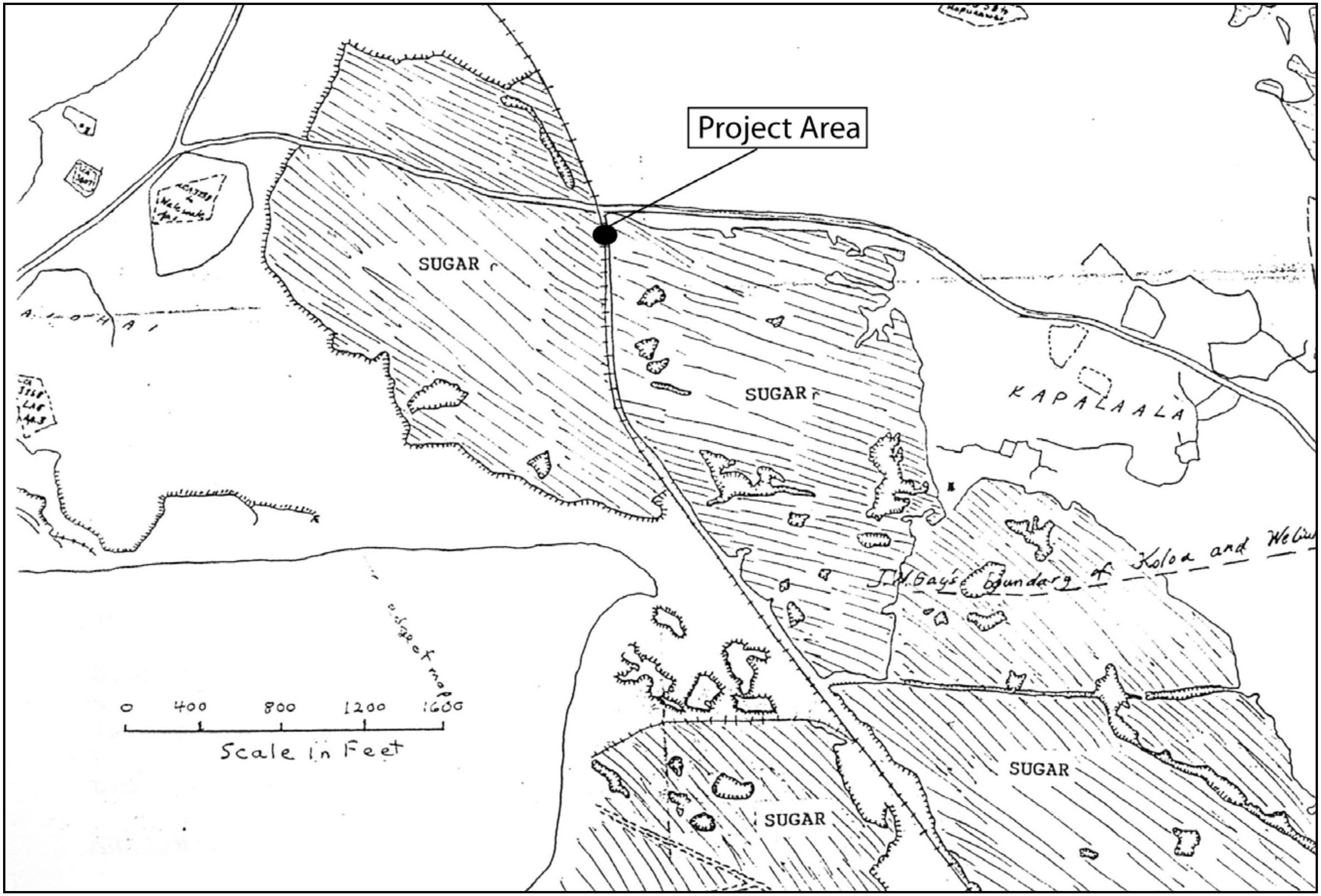

Figure 4. Map of lands belonging to Kōloa Sugar Co., C.R. Hunt 1911 (from Grove Farm), showing approximate project area

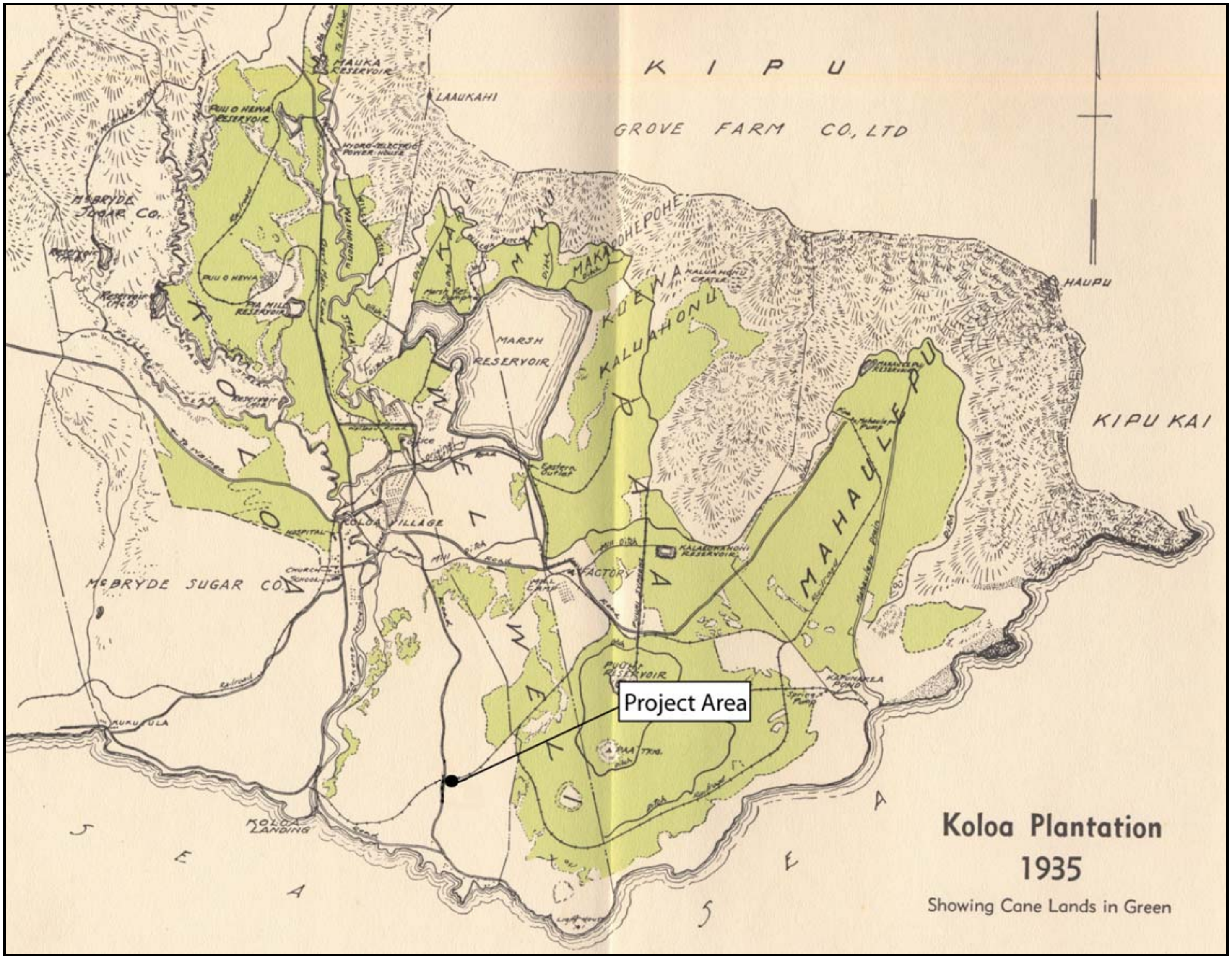

Figure 5. Kōloa Plantation 1935 map showing location of project area, sugar cane fields in green, and railroad from Kōloa mill to wharf at Kōloa landing

III. DATA RECOVERY PLAN

A. Description of State Site Subject to Data Recovery

State site 50-30-10-947 is the site subject to data recovery. In 1990, CSH (Hammatt 1990, 1991) performed an inventory survey and produced a data recovery and preservation plan for the Pōʻipulani Development Area. At this time, the historic railroad berm (state site 947) was given preservation status, based on the site criteria that the site is an excellent example of a site type, and that the site may be likely to yield information important to history. A section of preserved railroad berm runs southwest to northeast through the Village at Poʻipū phase I project area (Figure 6).

The berm is part of the Kōloa Landing sugar train railroad. Construction for the railroad began in 1882 (Conde and Best 1973), and this railroad was used to haul sugar from Weliweli and Paʻa to Kōloa Landing. The east branch of the berm traverses the parcel (TMK 2-8-14:19) for a distance of 1,650 feet (503 m) from southwest to northeast. The berm is constructed of stacked boulders with facing on both sides and a fill of smaller rocks and soil. At the southwest end of the parcel the berm reaches the greatest height of 1.8 meters and is consistently 3 meters wide. At the far southwest end is a constructed inset for an *ʻauwai* water flow under the berm. As the berm traverses NE it gets progressively lower and there is collapse of the facings in some sections. At the NE end the berm is nearly level with the ground surface, maintaining a height of 0.9 meters or less (Hammatt 1990:99).

Hammatt (1991:21) recommends that cross sectional drawings be produced during any demolition of portions of the structure, since little is known about the details of the railroad construction. Archaeological cross-sections of an intact portion of the berm have not been previously recorded. Simple cross-sections will allow documentation of the construction methods used to build the berm, and will compliment historic sources that discuss the railroad.

B. Anticipated Impacts to the Site

The edge of the proposed subdivision road at the location of the railroad berm is about 130 feet (40 meters) from Hapa Road (see Figure 6). The subdivision road is a paved road that will need to cut through the railroad berm (site 947). The railroad berm at this location is 6 feet (2 meters) high and 20 feet (6 meters) wide. The proposed road will require that about 50 feet (15 meters) from bottom slope to bottom slope of the berm be removed. From top slope to top slope a maximum of about 75 feet (23 meters) will be removed (Stanford Iwamoto, pers. com. Sept 28 and 30, 2004).

The slope of the cut end of the berm will be as close to the slope of the sides of the berm as possible. This slope will be partially dependent on what the construction material of the berm can hold and on county regulations. A 2 to 1 slope is standard, but a more vertical angle is the goal in this case since it is closer to the original sides of the berm and will minimize impact to the site. Dependent on the slope of the cut side of the berm, the amount of berm removed from upper slope to upper slope will be approximately 60-75 feet.

The stretch of railroad berm in the general area spans over 1600 feet (Hammatt 1990: 99). A relatively small section of the southwest portion, 50 to 75 feet, will be dismantled by bulldozer for the proposed road. The loss of this portion of the berm will allow for documentation of the construction methods used to build the berm. Since little is known about the construction of this historic site, the loss of this portion of berm is balanced by increased knowledge of the nature of the site.

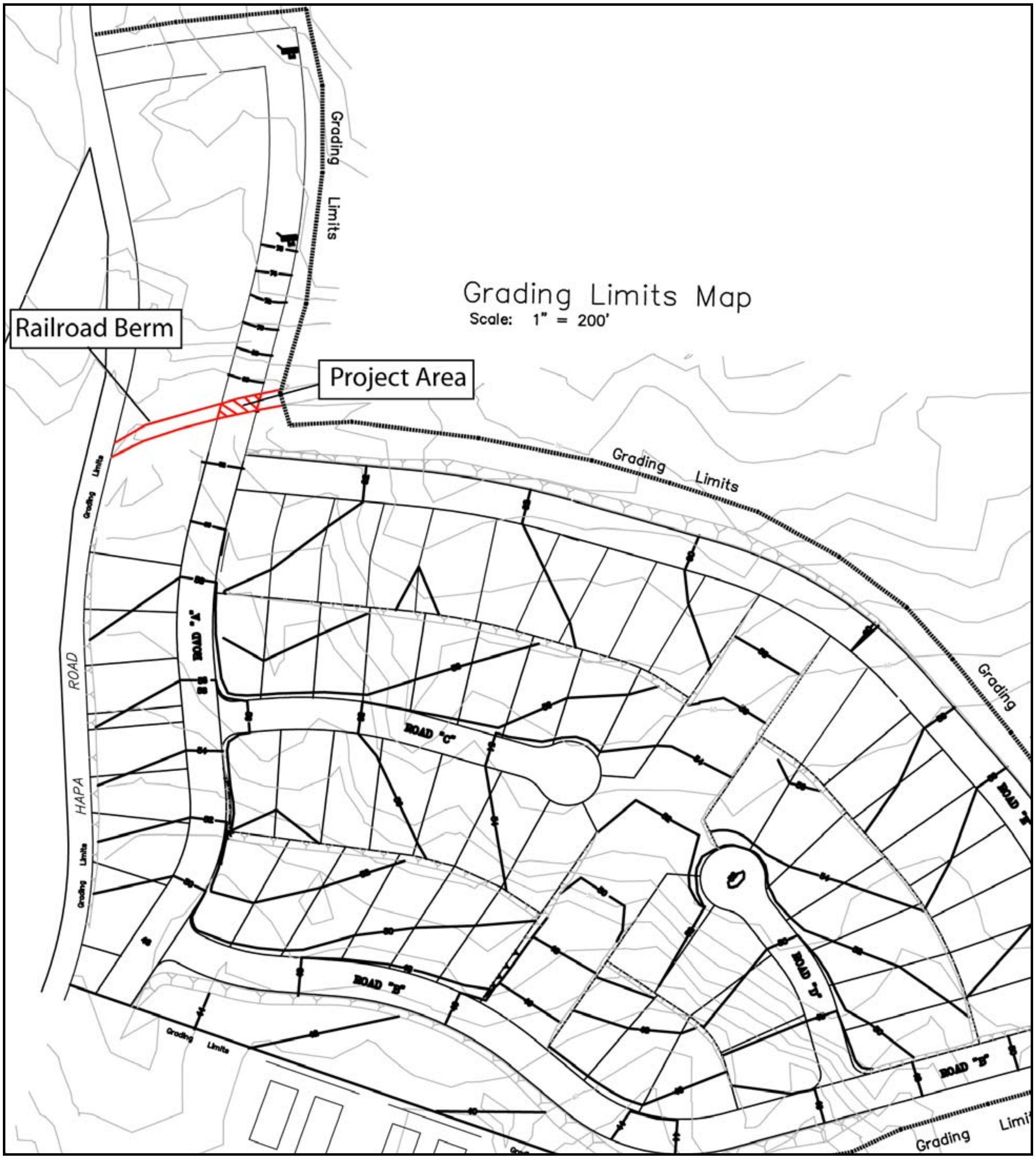

Figure 6. Grading limits map for Village at Po‘ipū, showing location of railroad berm within specific project area

C. Data Recovery Plan

Data recovery methods will consist of field study and documentation while the section of berm is being dismantled. In addition, primary historic documents will be examined. Documentation will consist of:

1. Photographs by a professional photographer

The photographs will be black and white archival quality prints, 8 x10 inches, and produced on archival quality photographic paper conforming to the Historic American Building Survey standards. Photographs will document the berm in profile before and after it is breached, as well as recording the cross-sectional view.

2. Cross-sectional drawings by an archaeologist

Cross-sections will be drawn as the bulldozer breaches the portion of railroad berm. Cross-sections for the inner portions will be recorded before reconstruction. Cross-sections will detail the type of facing rocks and fill that was used, to document the methods used to construct the berm historically, and increase our knowledge about the site.

3. Primary historic documents

Primary historic documents may provide additional information about when and how this portion of railroad was constructed. Sources that will be consulted include the Grove Farm Company, the McBryde Sugar Company, and the Kaua‘i Historical Society. This further documentation of the history of the Kōloa Sugar Company railroad should allow a more precise date for the site.

D. Reconstruction and Stabilization

An archaeologist will be present to draw cross-sections of the berm as it is breached, and archival quality photos will be taken of the berm before demolition for the access road. In addition, the cut ends of the berm will be stabilized using the materials from the breached portion of the berm. The cut ends will have the same slope as the preserved portion of the berm, as much as possible given construction materials and county regulations. This should help minimize impact to the site. Large facing rocks from the exterior portion of the berm will be used to finish the ends of the berm. Figure 7 shows a schematic of the berm and access road after construction.

E. Reporting

A draft report will be prepared after field work is completed, detailing findings of the field recording and historic research on site 947. This report will be submitted to SHPD for review and approval.

F. Curation and Disposition of Findings

Any artifacts recovered from the dismantled portion of the berm will be stored at the CSH laboratory. All artifactual material will be identified and catalogued, and representative items will be photographed or drawn to scale.

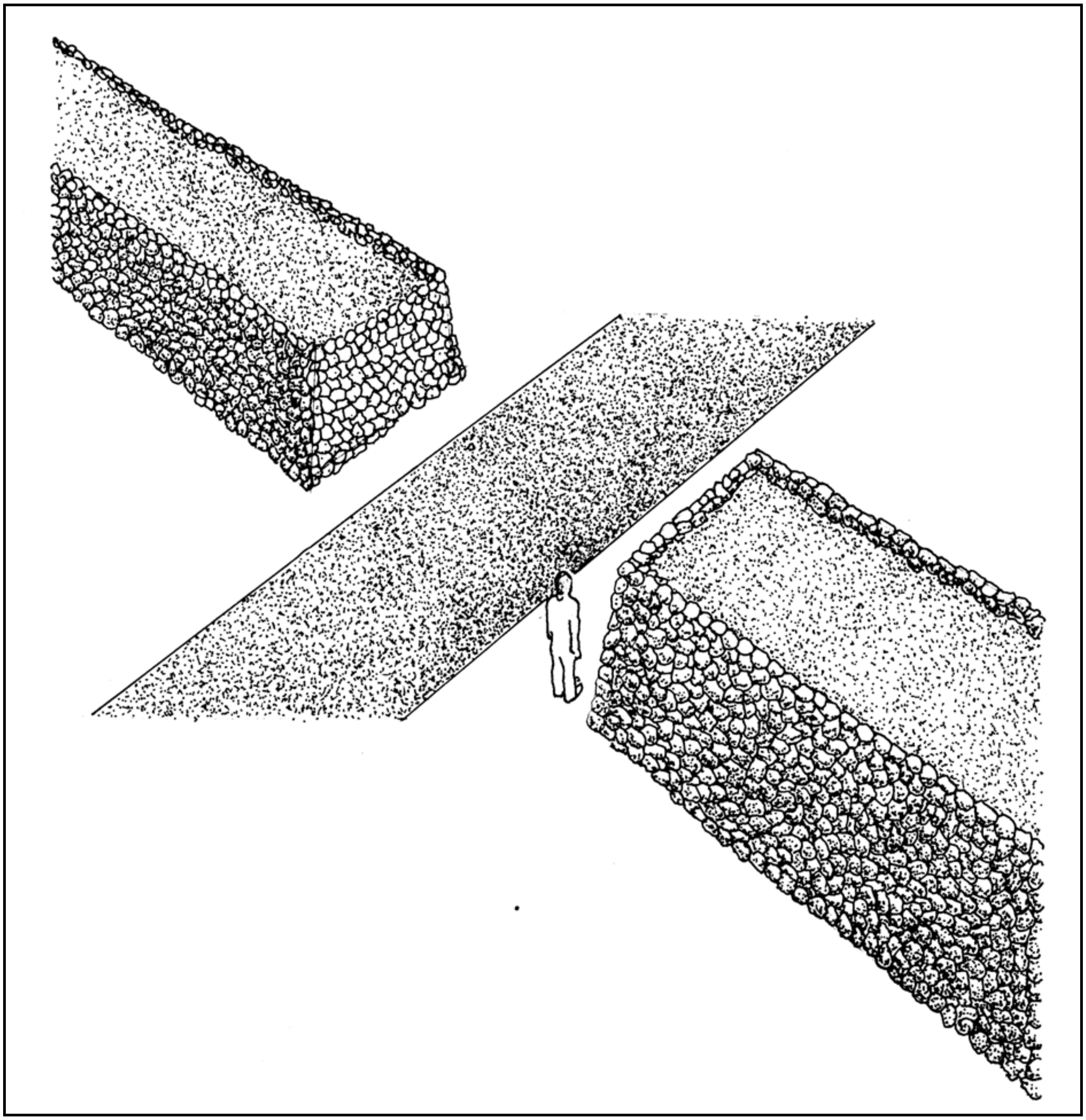

Figure 7. Schematic of railroad berm (site 947) and access road after reconstruction

IV. SUMMARY

State site 50-30-10-947 is a portion of the historic Kōloa Landing sugar train railroad, owned and operated by the Kōloa Sugar Company. A small section of railroad berm (approximately 50 to 75 feet) will be breached to allow for the Village at Poʻipū phase I project area access road. This document provides a data recovery plan for the demolition of a portion of the railroad berm, prepared to mitigate impact to the berm and address the State Historic Preservation Division's (SHPD's) regulations. The berm is a historic site dating to the end of the 19th century or early 20th century, and was used to haul sugar from Weliweli and Paʻa to Kōloa Landing.

No previous research has been carried out to document the construction of this important historical site. It is believed that the railroad berm has large facing rocks with small rocks and soil fill, but cross-sections of an intact portion of the berm have not yet been documented. Thus, the specific research objective defined is to record more information about the construction of the railroad berm. We believe this additional information about the construction of the railroad is proper mitigation for the relatively small amount of impact on the site. Research objectives will be met primarily by fieldwork, including the production of archival quality photos and archaeological cross-sections of the railroad berm as it is being breached. Cross-sections will detail the type of facing rocks and fill that was used, and how the berm was likely constructed. Reconstruction and stabilization of the ends of the berm, using large facing rocks from the demolished portion's exterior, will be completed after construction of the access road. Relevant primary historic documents will also be consulted, and should provide additional information on the construction of the railroad berm. A report of findings will be prepared for review and approval of SHPD.

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Appendix J

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
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March 30, 2005

Hal Hammatt, Ph.D.
Cultural Surveys Hawaii
P.O. Box 1114
Kailua, Hawaii 96734

LOG NO: 2005.0032
DOC NO: 0501NM03

Dear Dr. Hammatt:

SUBJECT: **Revised Historic Preservation Review - Interim Protection Plan for the Knudsen Trust Lands Phase 1 Portion of the Village at Po'ipu Project (Freeman and Hammatt, CSH, 2004)**
Koloa Ahupua'a, Kona District, Kauai Island
TMK: 2-8-14: 19 por.

Thank you for submitting the (Freeman and Hammatt) *Interim Protection Plan for the Knudsen Trust Lands Phase 1 Portion of the Village at Po'ipu Project, Koloa Ahupua'a, Kona District, Kauai Island*, CSH, ms., 2004, which we received on October 21, 2004. The plan calls for the protection of some 30 significant historic sites. Pages 39-41 of this plan list these sites and mitigation work that has already taken place. Please confirm whether data recovery has been completed and whether information obtained from data recovery is included on your list.

We understand that you are working on an updated inventory survey of the area. That report, along with mitigation plans (data recovery and preservation) should also be submitted the Kauai Historic Preservation Review Commission for their input.

The protective fencing seems to be around all 30 historic sites, which is based on the layout of the development and seems appropriate. The plan calls for buffer zones to be established before protective orange plastic fencing is erected. The plan does not call for the exact buffer zone, which should be at a minimum of 50 feet from the closest historic site. Please inform our office of the exact location and site of the buffer. This buffer zone and fencing needs to be verified by both the State Historic Preservation Division and the County of Kauai Planning Department.

The plan also calls for an on-site briefing for all the construction and landscape workers on this project. We concur with the interim protection plan, but await the long-term protection plan which should incorporate the above comments.

Aloha,

Melanie Chinen, Administrator
State Historic Preservation Division

NM:jen

c: Ian Costa, Planning Director

Interim Protection Plan for the Knudsen Trust Lands

Phase I Portion of the Village at Poʻipū Project

Kōloa Ahupuaʻa, Kona District, Kauaʻi Island

TMK: 2-8-14:19 por.

by

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Prepared for
Eric A. Knudsen Trust

Cultural Surveys Hawaiʻi, Inc.
October 2004

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I. INTRODUCTION

A. Project Background

This document comprises the interim preservation plan for historic properties on a portion of the proposed Village at Po‘ipū project area, TMK: 2-8-14: por 19, owned by the Eric Knudsen Trust in Kōloa, Kaua‘i (Figures 1-2). Included in this document are descriptions of all sites within proximity to any phase I construction activity associated with the proposed Village at Po‘ipū and how the sites should be protected during the course of construction activities. The project area is approximately 20 acres and is located *mauka* (north) of Po‘ipū Road. The project area is bordered on the west by Hapa Road with the modern 1970s Kīahuna Tennis Club forming a portion of the southern boundary. The purpose of this document is to provide an interim preservation plan that will satisfy the State Historic Preservation Division’s (SHPD’s) regulations.

B. Methods

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division of the Department of Land and Natural Resources and a review of documents and maps at the Cultural Surveys Hawai‘i library.

Individuals knowledgeable about the project area’s history are being consulted in conjunction with a companion Cultural Impact Assessment document that will cover this parcel as well as those comprising the entire proposed Village at Po‘ipū Development project (TMK 2-8-14: 1, 2, 3, 4, 19, 30 and 2-8-13:1).

C. Natural Setting

The project area is situated within 800 m (one-half mile) of the shoreline at an elevation of approximately ten to forty feet (3 m. to 12 m.) above mean sea level, on the southern coast of Kaua‘i in the *ahupua‘a* of Kōloa in the district of Kona. Waikomo Stream, approximately 1.5 km to the northwest, is a perennial stream and is the primary source of surface water in Kōloa.

The land here is constructed of the lavas of the Kōloa Volcanic Series that are post-erosional lavas less than 1.5 million years old (Macdonald and Abbott 1974). These Kōloa Series flows form a broad apron of predominantly *pāhoehoe* lava beneath the project area. The soil mantle in the project area is identified as very rocky Waikomo silty clay. It is aptly described as present on slopes ranging from two to six percent and having a representative profile comprised of a surface layer of dark grayish brown stony silty clay 14 inches thick, a six inch thick subsoil layer of reddish stony silty clay, and hard rock substratum (Foote et al. 1972).

Rainfall averages between 30 and 40 inches a year (Armstrong 1973); prevailing winds are from the northeast, and temperatures range from about sixty to ninety degrees Fahrenheit throughout the year. This dry environment with shallow soil today supports predominantly *koa haole* (*Leucaena glauca)*, exotic grasses, and weeds, though cattle grazing in the project area has kept the vegetation in check.

D. Scope of Work

The interim preservation plan will:

1. Identify each significant historic property needing interim protection
2. Specify interim buffer zones around each significant historic property
3. Specify short-term protection measures for each significant historic property that will be within or near a construction area

Figure 1. U.S. Geological Survey map, Kōloa quad., showing project area

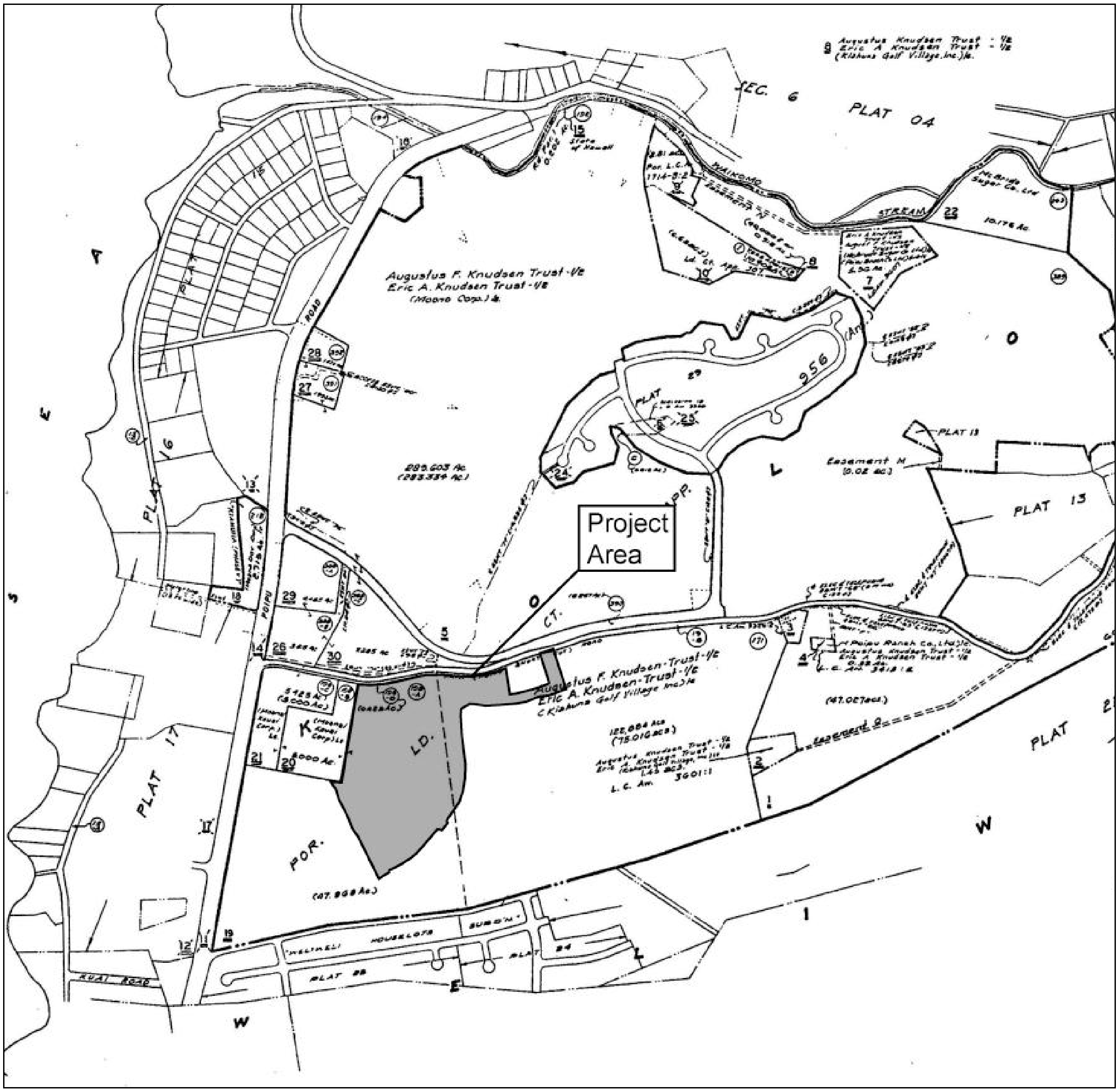

Figure 2. TMK 2-8-14 showing project area

II. HISTORICAL BACKGROUND

The project area is in the *makai* (seaward) section of the Hawaiian *ahupuaʻa* (land division) of Kōloa in the *moku* (district) of Kona. This *ahupuaʻa* extends as a fairly large land segment from Mt. Kāhili to the sea. It is bordered by Lāwaʻi Ahupuaʻa to the west and Weliweli Ahupuaʻa to the east.

A. Historical Setting: Pre-Contact Kōloa

Few records exist that document traditional Hawaiian life in the *ahupuaʻa* of Kōloa. While settlement by westerners with religious and commercial interests make the area a focus of documentation after the first quarter of the 19th century, the accounts generated generally focus on the lives and concerns of the westerners themselves, with only anecdotal references to the Hawaiian population. Two 19th century documents (Boundary Commission Testimony of 1874 and a Lahainaluna Schools manuscript of 1885), however, did provide two Hawaiians an opportunity to speak for themselves and thus offer a possible insight into the life of Kōloa before the arrival of westerners.

A dispute over the northern boundary of Kōloa Ahupuaʻa in 1874 led to a hearing before Duncan McBryde, the Commissioner of Boundaries for Kauaʻi. One native witness, Nao (who describes himself as born in Kōloa but presently living in Haʻikā), in order to show that Hoaea (the area in dispute) was indeed at the northern boundary of Kōloa, testifies: "At Hoaea tea leaves were hung up to show that there were battles going on" (Boundary Commission, Kauaʻi, vol. 1, 1874:124). That there was a traditional "warning system" --well-known to all natives--suggests that Kōloa, throughout its history, may well have been the scene of some serious conflicts--serious enough and often enough to warrant devising such a system.

Additional evidence of a rich history within Kōloa is offered in a Lahainaluna document produced eleven years later. This document appears to be based on an oral historical project. On September 7, 1885 a student from Lahainaluna Schools (HMS 43 #17) interviewed Makea – "a native who is well acquainted with Kōloa" -- and recorded "what she said about the well-known places in the olden times." More than sixty-four years after the abolition of the *kapu* (taboo) system and almost as many years of contact with westerners, Makea was able to describe fourteen *heiau* (religious structures) within the Kōloa area. For example, there was the *heiau* of Maʻulili:

> Maʻulili was the first heiau of south Kōloa. Kapulauki was the first chief of Kōloa, Kiha came next. That is the chief I know of. He was a ruling chief of Kauaʻi in the olden days, when the heiau was standing there. It had already been built and men had been sacrificed on its altars. This Kiha was called Kiha-of-the-luxuriant-hair. Another name for him was Kakae and another was Ka-pueo-maka-walu (Right-eyed-owl).
>
> This heiau was also famous for this reason -- it was the first heiau to which Kawelo was carried after he had swooned in Wahiawa, in the battle where stones were used as missiles.

> The location of this heiau was not known, but a deaf mute knew and it was he who pointed it out to the chiefs, and that is how it was rediscovered in the olden days.
>
> Kiha lived on the eastern side of the heiau and Aikanaka lived on the northeastern side. This chief, Aikanaka, was the one with whom Kawelo fought and he was the owner of this heiau at that time.

Clearly Kōloa was a particularly important *ahupuaʻa* in traditional Hawaiian times. That at least fourteen *heiau*–of varying sizes and functions–have been documented in the Kōloa area (Thrum 1907, Bennett 1931) and the association of legendary-historic figures such as Kawelo and Aikanaka with the *heiau*, suggests a heightened cultural richness of the *ahupuaʻa*.

B. Mythological and Traditional Accounts

There are several place names within Kōloa that have names and legendary associations. The name Kōloa itself has several derivations. Kōloa is the name for the large, soft Hawaiian sugar cane (*Saccharum officinarum*) once grown by the Hawaiians; Kōloa is also the name of a steep rock on the banks of Waikomo Stream, from whence the *ahupuaʻa* got its name. This bank of the river was called Kōloa, after the native Hawaiian duck (*Anas wyvilliana*) (Kikuchi 1963:46; Pukui *et al*. 1974:116).

Mau-lili (meaning constant jealousy) is a deep pool in Waikomo (*lit*. "entering water") Stream. When the gods Kāne and Kanaloa first came to Kauaʻi, they explored the island and came to the pool at Maʻulili at evening. They stretched out beside the pool for their night's sleep on its eastern bank and left the impress of their forms as can be seen in the *apapa* [a flat area]. The Maʻulili Heiau was first built by Ka-pueo-maka-walu, the son of Kapu-lau-kī. It was a place of human sacrifice (Wichman 1998:12). This *heiau* may be the Maʻulili Heiau described by Makea in the Lahainaluna document mentioned above. "The *apapa* in this vicinity is called an '*Unu*.' and a '*Heiau*,' but was never walled in, it is said. On the nights of Kāne the drums are heard to beat there, also at the sacred rocks, or *unu's*, of Opuokahaku and Kanemilohae, near the beach of Poʻipū" (Farley 1907).

There are additional legends associated with the Maʻulili area.

> In the Maʻulili pool lived a large *moʻo* [water spirit], named 'Kihawahine'...The eastern wall of the pool, just below the resting places of Kāne and Kanaloa, for a short distance, only, is called the 'Pali of Kōloa.' The District of Kōloa is named for this Pali, we are told by old Hawaiians. To the south of the Pali o Kōloa, in the wall is a rock named 'Waihanau' [meaning birth water]...as one of their *mele*s has it:
>
> *Aloha wale ka Pali o Kōloa,*
> *Ke Ala huli i Waihānau e, hānau.*
>
> To the south of Waihānau is a projecting rock named '*Ke elelo o ka Hawaiʻi*' -- the tongue of Hawaiʻi, said to have been wrested and brought from Hawaiʻi by the Kauaʻi warrior Kawelo, of Wailua.
>
> At the southern end of the Maʻulili pool started two large *ʻauwai*'s [irrigation ditches], that watered the land east and west of Kōloa (Farley 1907:93).

Thus, this sacred legend-imbued locus was the source that gave life to the lowland taro patches of Kōloa. These special associations would not have been lost on the Hawaiians dependent upon those waters. While taro would have been essential to the life of the *ahupua‘a*, other resources were available. Bernice Judd, writing in 1935, summarizes most of what was known -- into the first decades of this century -- of the traditional Hawaiian life of Kōloa:

> In the old days two large *‘auwai* or ditches left the southern end of the Ma‘ulili pool to supply the taro patches to the east and west. On the *kuauna*s [embankments] the natives grew bananas and sugar cane for convenience in irrigating. Along the coast they had fish ponds and salt pans, ruins of which are still to be seen. Their dry land farming was done on the *kula*, where they raised sweet potatoes, of which both the tubers and the leaves were good to eat. The Hawaiians planted *pia* [arrowroot] as well as *wauke* [mulberry] in patches in the hills wherever they would grow naturally with but little cultivation. In the uplands they also gathered the leaves of the *hala* [screwpine] for mats and the nuts of the *kukui* [candlenut] for light (Judd 1935:53).

C. Early Historic Period

Early historical and ethnographic information suggest that Kōloa was well populated during the late pre-contact period. The earliest explorers, like Cook and Vancouver, used Waimea for anchorage and victualizing, with no mention made of Kōloa. However, their descriptions of well-maintained, watered agricultural systems, on this dry leeward coast, are echoed in the early descriptions of Kōloa. During Captain Cook’s first visit to Kaua‘i in 1778, he noted:

> What we saw of their agriculture, furnished sufficient proofs that they are not novices in the art. The vale ground has already been mentioned as one continuous plantation of taro, and a few other things, which have all the appearance of being well attended to (Cook 1818).

In 1792, Vancouver visited the island, again anchoring in Waimea Bay. He recorded of the surrounding countryside:

> … the low country which stretches from the foot of the mountains toward the sea, occupied principally with the taro plant… interspersed with some sugar-canes of luxuriant growth and some sweet potatoes (Vancouver 1798).

Systematic historic records began with the founding of the American Protestant Mission at Kōloa in 1834 under the Reverend Peter Gulick. On December 31, 1834, Peter Gulick and his family arrived in Kōloa. Apparently the first foreigners to settle in the *ahupua‘a,* they initiated the process of rapid change that would re-shape the life of Kōloa in the nineteenth century. In 1835, a 30 by 60 foot grass house was erected as a meeting-house and school (probably located at Kōloa Town). Mr. Gulick initiated sugar cane cultivation and collected a cattle herd for the Protestant Mission. In 1837, a 45 ft. by 90 ft. adobe church was built and the first mission doctor, Thomas Lafon, arrived to assist Mr. Gulick (Damon 1931:179, 187). The Kōloa mission station apparently flourished immediately. Charles Wilkes, a member of the U.S. Exploring Expedition, visiting Kōloa in 1840, recorded:

> The population in 1840, was one thousand three hundred and forty-eight. There is a church with one hundred and twenty-six members, but no schools. The teachers set apart for this service were employed by the chiefs, who frequently make use of them to keep their accounts, gather in their taxes &c. The population is here again increasing partly by immigration, whence it was difficult to ascertain its ratio (Wilkes 1845:64).

Other sources, however, give different population figures for Kōloa during the first half of the nineteenth century. In 1834, according to a report by missionaries on Kaua‘i, the inhabitants of the *ahupua‘a* numbered 2,166 (*Kaua'i answers,* 1833, cited in Palama and Stauder 1973:16; also found in the newspaper, *Garden Island* July, 27, 1935). However, in this census, Kōloa was used to refer to the whole area between Wahiawa and Kalapaki. An article in the *Pacific Commercial Advertiser* of December 21, 1867 estimated that the population in 1838 was about 3,000. By 1867, it had been reduced to a third of that number. James Jackson Jarves, who visited Kōloa and Kaua‘i for nine months during the early 1840's, recorded:

> Kōloa is now a flourishing village. A number of neat cottages, prettily situated amid shrubbery have sprung up, within two years past. The population of the place, also, has been constantly increasing, by emigration from other parts of the island. It numbers, now, about two thousand people, including many foreigners, among whom are stationed a missionary preacher, and physician, with their families (Jarves 1844:100).

In 1834, two American naturalists, John K. Townsend and Thomas Nuttall, traveled to Kōloa in search of specimens. Townsend noted that from Kōloa Landing to the missionary station were fields of taro, yam, and maize on both sides of the road; it is possible that he confused maize with Hawaiian cane. He observed irrigation networks, as well as sweet potato patches in the dryer areas. In many cases, these patches were protected with stone walls (Townsend 1839:206).

Jarves (1838:69) remarked on the fields of sugar cane, taro, yams, vegetables, which indicated a more than usual attention to agriculture. Judd (1935) describes large ‘*auwai* (irrigation ditches) drained from Ma‘ulili pond near the present Kōloa town to supply taro patches in the area. She states:

> ... on the kauna or embankments, the natives grew bananas and sugar cane for convenience in irrigating. Along the coast they had fishponds and salt pans, the ruins of which are still to be seen. Their dry land farming was done on the kula, where they raised sweet potatoes, of which both the tubers and leaves were good to eat. The Hawaiians planted pia (arrowroot) as well as wauke (mulberry) in patches in the hills wherever they would grow naturally with but little cultivation. In the uplands they also gathered the leaves of the hala for mats and the nuts of the kukui for light (Judd 1935: 289-290).

Judd also observed that the population of Kōloa must have been several thousand before European contact. By the time of the first missionary census in 1834, the population stood at 2166. She (Judd 1935:290) observed that, in spite of the large population, there was no clustering of houses into villages. Rather, they were scattered along the main streams and *‘auwai*.

Handy (1940:65) identifies at least three named irrigation systems in Kōloa. One of these, named Niʻihau, was fed by upper Waikomo Stream. It was adjacent to the Catholic Church and therefore located in the present survey area.

A visitor in 1845 recorded other notable features, including caves used for habitation. In his journal, Gorham Gilman describes "some natural caves near the sea side." What he saw in one cave was only the most recent version of a scene that must have taken place there over countless generations:

> . . . looking round I saw a large hole in the ground near me, into which we descended by a pile of stones raised from the bottom for that purpose. . . here a strange sight met out view, there were some dozen or more natives seated around, some preparing a pig for the fire, other curing their tobacco & all engaged . . . and making the place a natural kitchen (Gilman n.d.:11).

The first changes from the traditional agricultural and habitation patterns began in the 1830s, when two sugar mills began production. Several Chinese erected a crude mill with. granite rollers in the Mahaʻulepu area. Cane grown by the natives was ground there; however, when a much larger mill operated by Ladd and Company began a few years later, the Chinese mill went out of business. The mill and plantation operation resulted in an increase in emigration from other areas of Kauaʻi. The population was estimated around 3000.

The advent of the Ladd and Company enterprise transformed Kōloa into a commercial center. Activity at Kōloa Landing has been described:

> The port of Kōloa did a remarkable amount of trade considering the fact that the roadstead was not safe except when the trade winds blew. Most vessels preferred not to anchor but to Lay off during the process of loading, rather than risk the chance of being wrecked by a sudden change of wind. An estimate in 1857 stated that 10,000 barrels of sweet potatoes were grown each year at Kōloa and that the crop furnished nearly all the potatoes sent to California from Hawaiʻi. Sugar and molasses were also chief articles of export (Judd 1935:325-326)

Other agricultural ventures were attempted, however, none too successfully. Mulberry fields were started for silkworms, but wind and drought killed them off. An attempt was made to develop a commercial market for *kukui* nut oil, but this failed as well. Tapioca was manufactured from cassava root during a brief period during the 1860s, but was apparently not commercially successful.

All of these agricultural ventures, along with the increasing emphasis on sugar production, led to large scale modification of the land. It is likely that fields previously used for taro production were modified for new cash crops such as sweet potatoes, and, in some cases, were abandoned or destroyed to make room for commercial crops. By 1884, most of the land at Kōloa had been given over to sugar production.

Within the project area, it appears that the effects of commercial cultivation were minimal. Clearing for cane cultivation occurred only along the banks of Waikomo Stream. Modifications to traditionally used agricultural fields are not clearly apparent, although substantial high walls superimposed on irrigated field walls and across *ʻauwai* channels suggest a change in land utilization from one of strict cultivation to one supporting both cultivation and ranching.

D. Mid-1800s –Māhele Era

By the mid-19th century, control of the *ahupua'a* was divided between Kamehameha III and Moses Kekūāiwa, a brother of Kamehameha IV (Alexander 1937). The *Māhele* records indicate that Kōloa Ahupua'a--8,620 acres–was awarded (LCA 7714-B) to Moses Kekūāiwa, the brother of Alexander Liholiho (Kamehameha IV), Lot Kapuāiwa (Kamehameha V), and Victoria Kamāmalu. One segment was leased to Ladd and Company in the 1830s for sugar cane cultivation. At the time of the Great *Māhele*, a number of small holdings (*kuleana*) were granted for homesteading and farming (Office of the Commissioner of Public Lands 1929).

Eighty-eight kuleana were awarded to individuals within Kōloa Ahupua'a. The majority of these Land Commission Awards (LCAs) were located in or around Kōloa Town itself and along Waikomo Stream. This concentration of awards around the town and stream may reflect the traditional land settlement pattern, a focus on the resources of Ma'ulili Pool and Waikomo Stream (a permanent stream), and a more recent movement of the populace to the plantation and missionary centers. No individual kuleana were awarded in the project area.

E. Mid-1800s to Present

Kōloa became the scene of the confrontation of the traditional social structure with commercially impelled forces of change. The cane growing activity of Ladd and Company would inevitably affect the lives of the inhabitants of the rest of the *ahupua'a*. Traditional settlement patterns (*e.g.* permanent and temporary habitation interspersed throughout the irrigated agricultural fields near the coastal zone and traditional farming along streams) would have been distorted by a shift to Kōloa Town where sugar cane milling activities were located, and a shift to cash crops other than taro.

Although Ladd and Company would go bankrupt in 1845; its earlier success was an impetus for other entrepreneurial attempts within Kōloa. Silkworm farming, oil extraction from *kukui* nuts, cigar manufacturing, sago raising, and tapioca manufacturing were all attempted with varied success during the middle third of the nineteenth century. Ladd and Co. incorporated as the Kōloa Sugar Company in 1880, following a succession of individual and partnership owners. In 1948, the Kōloa Sugar Company became part of the Grove Farm Company.

Another major area of commercial enterprise was associated with the whaling industry at Kōloa Landing, whose peak years ran from the 1830's to the 1860s. Accounts of visitors suggest that the inhabitants of Kōloa, took advantage of their nearness to the landing to participate in the booming trade of the port. An article in the *Pacific Commercial Advertiser* of Feb. 19, 1857 described the salient characteristics of the port at mid-century and mentions:

> The anchorage is an open roadstead, the tradewind blowing along and a little off shore. During the prevalence of trade it is safe for ships to anchor, but they rarely do so, preferring to procure their supplies ‘lying off and on’. The anchorage for schooners is close to shore, in four to six fathoms of water…somewhat sheltered from the wind by a bluff. Owing to the force of the swell and the suddenness which the south wind sweeps around the head lands of the island…a number of coasting vessels have been wrecked of late years in this port. For the trade of the port there is a small rude pier constructed which might be improved at no great outlay of labor. From the landing there is a good carriage road to the town, distant about two miles. Large quantities of firewood, bullocks and sweet potatoes are furnished to whalers in this port, and these chattels can nowhere be procured cheaper or better. It is estimated that 10,000 barrels of sweet potatoes are cultivated annually here, which are thought to be the best on the islands. Nearly all the potatoes furnished for the California market are produced here… Sweet potatoes, sugar and molasses constitute the chief trade of the port.

In 1882, the Kōloa Sugar Co. announced the construction of a railroad plant, consisting of four miles of 3-inch gauge track, forty cars 5 x 210 feet, and one locomotive (Conde and Best 1973:159). The first tracks were probably laid between the cane fields and the sugar mill. By 1910, the rails extended to Kōloa Landing where the steamers transported the bags of sugar to the mainland. In 1910, the *San Francisco Chronicle* commented:

> Cane is transported from the fields to the mill over a railroad system that consists of fifteen miles of permanent track, two miles of portable track, 250 cane cars and track, two miles of portable track, 250 can cards and four locomotives. About two miles from the mill and connected with by rail is the steamer landing, with a warehouse that will hold 20,000 bags of sugar (cited in Conde and Best 1973:159).

Kōloa Landing was phased out around 1925 when McBryde Sugar Company and Kōloa Sugar Company began using the alternate Port Allen. Soon after this the sugar companies ceased to use the *makai* Kōloa fields, and much of the area was converted into pastureland, used for cattle grazing by the Knudsen family. A map of Kōloa Plantation (Figure 3, Alexander 1937) shows the extent of the sugar cane fields in 1935. The map shows the locations of sugar cane fields, none of which are located within the project area, which would have been too rocky for sugar cane cultivation. The map also shows the railroad berm, which cuts through a portion of the current project area and extends from Kōloa Mill to Kōloa Landing. Some inland areas of Kōloa remained under sugar cane cultivation until at least as late as the 1970s, when these cane lands were converted into pasture.

F. Summary of Historical Background

Although much of the seaward portion of Kōloa is a relatively dry area with approximately 30 inches of rain per year, the perennially flowing streams provided a resource for the development of a rather expansive agricultural system. Accounts of the early history of Kōloa (Farley 1907; Jarves 1844; Townsend 1839; and Judd 1935) describe in the lands *mauka* of Kōloa Town a seemingly continuous, well-maintained, agricultural complex of taro, yams, sweet potato, and sugar cane that was irrigated by an extensive *‘auwai* system siphoned off of Waikomo and Pōʻeleʻele streams. This system had a significant influence on later commercial endeavors in Kōloa.

Kōloa is the site of the first organized sugar plantation in Hawai‘i. Ladd and Company leased about a thousand acres for the sole purpose of growing sugar cane (Palama and Stauder 1973:18, from Judd, 1935). The commercialization of sugar cane in Kōloa had widespread social effects. The traditional view of the *‘āina* (land) being a responsibility of the *ali‘i* (chiefs) was being transformed.

Kōloa Town, and Kōloa Landing, at the mouth of Waikomo Stream, became prominent commercial centers during the mid to late 1800’s, exporting a variety of products such as sweet potatoes, sugar and molasses. Whalers also stopped for provisions of squash, salt, salt beef, pigs, and cattle (Palama and Stauder 1973:20). This heightened activity dramatically altered the social structure and landscape of Kōloa. Kōloa soon reflected the effects of a traditional social structure in conflict with commercially impelled forces of change. Traditional settlement patterns (e.g. permanent and temporary habitation interspersed throughout the irrigated agricultural fields near the coastal zone and along streams in the steeper valleys inland) would have been significantly changed by a flux to Kōloa Town where sugar cane milling activities were located. Later land use in Kōloa (i.e. sugar cane, pasture) also had detrimental impacts on any surviving traditional structures.

Consultations were undertaken with two knowledgeable persons, Mr. Louis Jacintho and Mr. Manuel Andrade, regarding the land use history of the current project area. Mr. Louis Jacintho, a lifelong Kōloa resident, was born in Portuguese Camp in Kōloa on December 19, 1924. In 1939, he began working for Kōloa Sugar Company, which was taken over by Grove Farm in 1948. He retired in 1986.

Mr. Jacintho is acquainted with the project area and stated that he used to hunt pheasants in the project area in the 1950s. He stated that he does not recall any rock walls associated with cattle ranching and that the rock walls he recalls in the general area are remnants of traditional Hawaiian settlement.

Mr. Jacintho stated that he recalls cattle in the area and noted that most sugar plantations had cattle operations on lands where sugar could not be grown. The plantations had their own slaughterhouses (e.g., McBryde Sugar had one in Kalaheo) and the beef was sold locally. He stated that the Kōloa Sugar Company had “lots of cattle.”

Mr. Manuel Andrade presently runs cattle in the current project area and has been for over 7 years. Prior to this, his family ran a slaughterhouse where Knudsen beef were processed, so he is well aware of cattle activities in the area. Mr. Andrade provided the name of an old time cowboy, Mr. Ortiz, who lives in Kōloa and worked for Knudsen his whole life. Mr. Ortiz will be contacted in conjunction with a planned cultural impact assessment for the Village at Po‘ipū project.

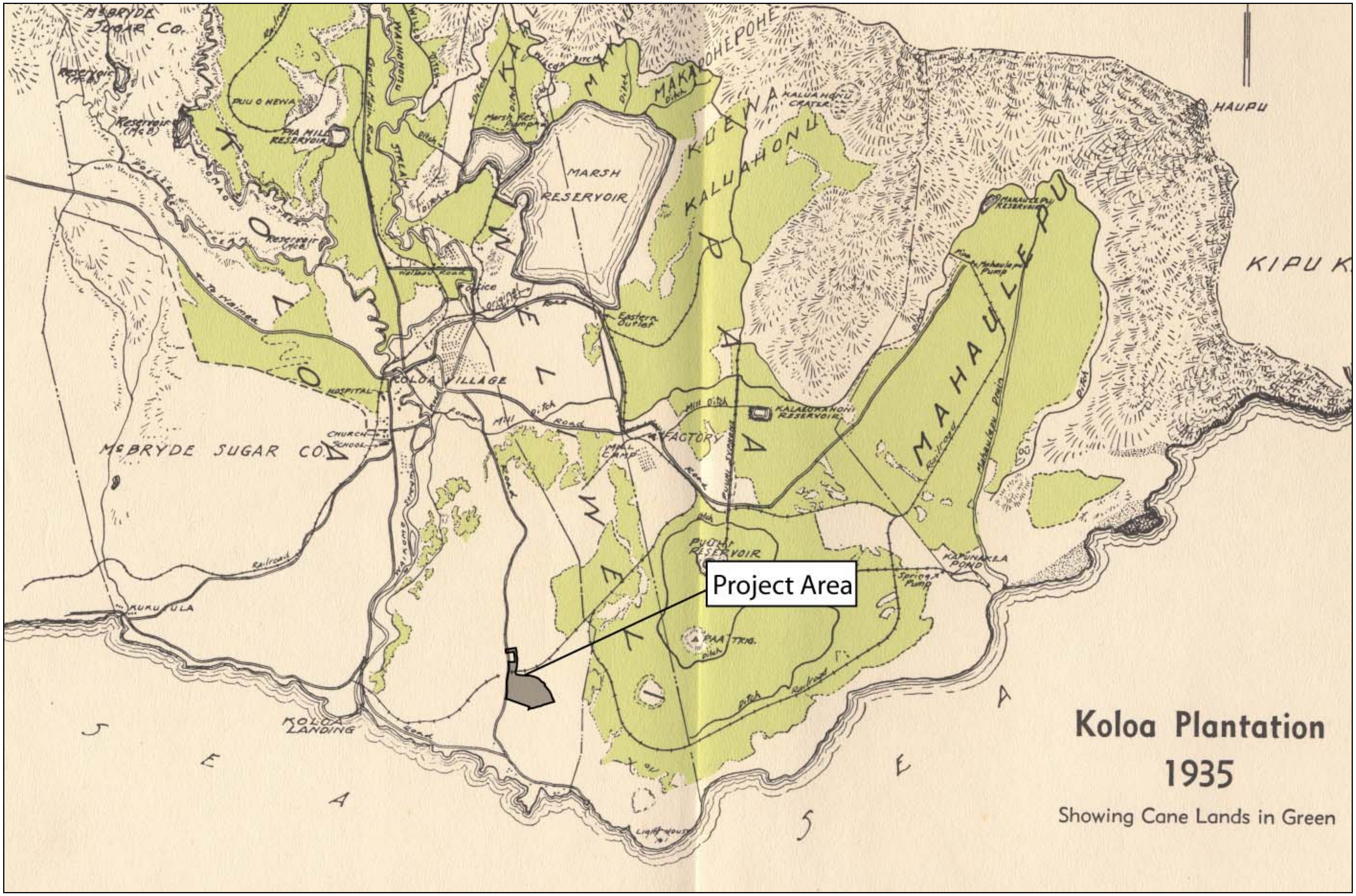

Figure 3. Kōloa Plantation 1935 map showing location of project area, sugar cane fields in green, and railroad from Kōloa mill to wharf at Kōloa landing

III. PREVIOUS ARCHAEOLOGICAL RESEARCH

A. Early Surveys of Major Sites in Kōloa

Archaeological research before 1960 was limited to oral history accounts and surveys of the larger more important sites, especially *heiau* sites along the coast. The first survey of an inventory nature of Kōloa resulted in a catalog of features for the general Kōloa region. This is a listing of temples and shrines (Lahainaluna Schools 1885), of which some may be in the present study area. The most important is Maʻulili Heiau in Kōloa.

> The first heiau of southern Kōloa. Kapulauki was the first chief of Kōloa, Kiha came next. This Kiha was called Kiha of the luxuriant hair (Kiha-ke-oho-lupalupa). Another name for him was Kakaʻe and another was Ka-pueo-maka-walu. Men were sacrificed on it. The *heiau* was famous because Kawelo was laid on its altar. Kiha lived on the eastern side of the *heiau*, and Aikanaka on the northeastern side.
>
> There are three areas in Kōloa named Maʻulili. One is along the coast and is called Maʻulili-kai. One is inland…[the]third is in the town of Kōloa (Kikuchi 1963:84).

Other religious structures described in the Lahainaluna survey include:

> Kue-manu Hieau: It was located at Kualu in Kōloa. Kualu was the chiefess who built it, but any story pertaining to this heiau is not remembered. Human sacrifices were offered there. There was heiau at Wailua similar to this one so it was thought the same chiefess built that one too.
>
> Manini Heiau: Manini was another heiau of Kōloa. It stood near the beach. The heiau was for the gods of the sea, that is Kuhaimoana and others. On the nights of Kane these fish-gods came up to the beach. Their spirits took possession of their keepers, then these men went into the heiau to drink awa. The people were accustomed to doing this in the olden days. On each night of Kane in every month, the drum was beaten to proclaim a kapu on the beach. Men were not allowed to go to the beach at night lest they step on the fish (gods).
>
> Kuhahapo Heiau: Kuhahapo was another heiau. It was Located on the cape of Kahala in southern Kōloa. Hogs and red fish were offered there. The chief who built it is not known.
>
> Louma Heiau: Louma was another heiau, which also stood in southern Kōloa on the mountain side of Ho ʻo-leina-ka-puaʻa (place-to-throw-in-the-pig), a pond on the mountainward side of the houses. The heiau was close by. Kiha was the chief to whom it belonged. It was a small heiau in which hogs, red fish, etc. were offered.
>
> Lonoikaoualii was the chief and Wakea was the priest who brought the stones from Oahu.

Hale-oio Heiau: Haleoio was another heiau. It was also in southern Kōloa, on the beach . The thing for which this heiau is noted was that when schools of Weweo (a red fish) went to Kahaoi, they also came to this place.

Kaulia Heiau: Kaulia was another heiau. It was very close to the eastern side of Kamohoalii‘s taro patch, because the heiau was also his. It was a heiau in which to offer hogs and red fish, for the relief of physical ailments. That was the only thing done in this heiau.

Mauna-pohaku Heiau: Maunapohaku was another heiau. It stood on Nahinu‘s property in southern Kōloa. The name of the chief who built it and that of the priests who officiated there is not remembered.

Ka-i‘a-iki Heiau: Kaiaiki was another heiau that stood on the mountainward side of the road leading down to the wharf at [Kōloa] landing. It was on the eastern side in southern Kōloa.

Kuhahape Heiau: Kuhahape was another heiau which was located by a seapool on the beach of Kōloa.

Halau-a-ka-lena Heiau (Site 50-30-10-3074): The heiau now completely destroyed once stood at the shore at a promontory called Kai-halulu. Kihawahine was its goddess. Dogs, hogs, and red fish were offered there in the olden days. In times of trouble such as sickness, the priests took offerings there.

Kamalo‘ula Heiau (Site 50-30-10-3076): Located at Kamaloula, that was the site of Makea’s house (female). This heiau was built for the purpose of multiplying food plants.

Ho‘ai Heiau (Site 50-30-10-75): Located at the birth place of Prince Kūhiō. The heiau complex consists of 5 separate platforms all interrelated to each other. Most were paved. . . A round fireplace with sand bottom was noted on one of the platforms. A rectangular pit had two unusual stones shaped like the human foot or lower leg. Evidently these were items of worship.

Kiha-Houna Heiau (Site 50-30-10-80): Kiha-Houna. Heiau for the gods who are Hulukoki, Kane, Kamohoali‘i, and Kuhaimoana. The heiau was dedicated to these gods.

Kane-i-olo-uma Heiau (Site 50-30-10-81): on the shore a short distance east of site 80…at Po‘ipū, Kōloa.

Papa Shrine: Papa was a fish altar on the beach on southern Kōloa. It was a place on which red fish and hogs were offered and was also a place on which the fishermen’s first catch as laid (Kikuchi 1963).

Thomas Thrum was the next to discuss sites in the Kōloa area in his list of the *heiau* of Kaua‘i. He discussed six *heiau* in the district of Kōloa, which once extended from Hanapēpē to Māhā‘ulepū. The *heiau* were Hanakalauae, Kanehaule (inland Kōloa Ahupua‘a), Kihouna (Kōloa Ahupua‘a), Kaneiolouma (Kōloa Ahupua‘a), Weliweli (Weliweli Ahupua‘a), and Waiopili (Māhā‘ulepū Ahupua‘a). The two *heiau* on the Kōloa coast, Kaneiolouma and Kihouna, were described as: “Near the Poipu beach, at Kōloa, are two walled *heiau* but a short distance apart.” (Thrum 1907:36-37; 68)

The earliest systematic archaeological survey on the Island of Kaua‘i was conducted by Wendell Bennett in the late 1920s. Bennett examined and recorded 202 sites on the island. According to his site location map, Sites 74 to 81, 85-86, and 91-92 may be in the *ahupua‘a* of Kōloa (Bennett 1931:98).

Site 50-30-10-85 consists of walls, enclosures, and house sites, "...in the cactus covered country around the Kōloa reservoir and extending to the sea."

> Innumerable walls, some of them enclosures and some merely division walls and fences. In one large, walled enclosure were three piles of stone near one end. The center one, and the largest, was 10 by 7 feet and 2 feet high. It was built up around the edge with large stones and felled with 2-inch pebbles. On each side of this structure was a 3 by 3 by 2-foot pile of rocks. There are some fine house sites on flat places on the lava flows, slightly leveled with small stones. House sites about 10 by 15 feet are found everywhere on the lava. The walls are of different types of construction and some have been restored for modern use; double rows of large stones on edge filled in with small stones; walls built up of same size stones; walls built of blocks of lava set upright. Some walls are 6 feet and others 2 feet high (Bennett 1931).

Site 50-30-10-86 is described as a house site in the same area as site 85 above.

> This special house site is rectangular, 25 feet wide, and 45.5 feet long, enclosed by walls 2 feet wide and about 2 feet high. It is divided into two sections. The south section is paved with small stone and has a terrace across the southern end. East of this section, outside the wall, is a roughly paved irregular area. The roughly paved north section is one foot lower than the south section, the walls being correspondingly higher. Outside the west wall of this house near the center is a paved platform in which is a square depression. The walls of this house site are made of double rows of stones on edge with a small stone fell between them. Coral is found in the walls. Southwest of this site is another, with walls on three sides only, which measures 15 by 15 feet (Bennett 1931:120).

Site 76 consists of numerous salt pans, east of Waikomo Stream along the shore. Site 77 consists of four ponds just inland from the shore road east of site 76. Site 78 is a series of taro terraces and habitation areas, just east of site 77 and adjoining it. Site 79 is a large enclosure and house sites just northeast of site 78.

Site 50-30-10-80, Keha-Houna Heiau, located on the point between the Waiohae and Po‘ipū Beach Hotels, is significant as the only surviving major religious structure located along the south coast of the island of Kaua‘i. It is only one of two *heiau* still located along the entire District of Kona (the other being Polehale Heiau, site 50-30-01-1).

B. Modern Archaeological Surveys in the Kōloa Area

Beginning in the 1960s, several large archeological surveys were carried out in Kōloa. Figure 4 shows the locations of these and other previous archaeological studies in the vicinity of the current project area. Table 1 provides an overview of previous archaeological projects conducted in the vicinity.

William Kikuchi (1963) conducted a general survey of the Kona District of Kaua‘i including all *ahupua‘a* from Hanapēpē, eastward to Kīpū Kai. Information from Thrum (1907), Bennett (1931), a Lahainaluna School manuscript (1885), and other sources was instrumental in helping to locate major archaeological sites during the field survey. Kikuchi’s survey was selective since it was not designed to be a complete inventory, and focused on generally larger or more coastal sites. No sites were recorded as being in the present project area. Kikuchi listed sites mentioned in other sources, but not relocated by him. In Kōloa, this included the *heiau* of Ma‘ulili. There are three areas in Kōloa named Ma‘ulili, the shore area, called Ma‘ulili-kai, the area inland of this, and an area in the town of Kōloa. Kikuchi believed that Ma‘ulili Heiau once was on the shore.

During the 1973-1974 State Wide Inventory of Historic Places performed by ARCH of the County of Kaua‘i for the State of Hawai‘i, the archaeological remains first identified by Bennett (1931) *mauka* (north) of the present project area (Site 50-30-10-85) were briefly evaluated and placed on Reserve status. Archaeological sites are placed in this category because they need additional research and must be saved until they can be placed into one of the other categories. These include: 1) High Value - sites that must be saved; 2) Valuable - sites that should be saved; 3) Marginal - can be destroyed with reservations; and, 4) Destroyed - all traces obliterated.

Stephen Palama and Catherine Stauder (1973) conducted a reconnaissance survey along the route of the then-proposed main cane haul road to the Kōloa mill site, *mauka* (north) of the present project area. The proposed new section of road extends from Weliweli Road, southwestward across Po‘ipū Road, connecting to an existing cane haul road. This road corridor crosses a portion of Weliweli Ahupua‘a and both east and west Kōloa at a distance of between two-thirds to two miles from the coast. A total of 18 sites were recorded along the road corridor. Although the Palama and Stauder study was limited in scope to the proposed road right of way, it included a short but thorough historical summary of the place of archaeological sites within the context of the Kōloa and Weliweli Ahupua‘a. An extensive *‘auwai* system was observed east of Po‘ipū Road. The following comments on this system and the sites in general are relevant to understanding the archaeological significance of the area as a whole, and the historic processes at work:

> Our reconnaissance revealed that the most significant archaeological feature located within the study area is the extensive *'auwai* system. Remnants of this irrigation system were observed on both sides of the Waikomo Stream…[This] network of watering canals proved to be the key to the success of the prehistoric Hawaiian Culture in turning these marginal lands into flourishing wet and dry agricultural fields. From information gathered from local informants and preliminary historical investigation of this area it is evident that the early commercial growers of sugar cane utilized the existing *'auwai* system. Gradually as more and more fields came under sugar cane production these replaced the wet and dry fields of an earlier day.
>
> Today the archaeological sites remaining stand as islands as these marginal cane lands were taken out of production and turned into pasture (Palama and Stauder 1973:4).

A survey by ARCH in 1974 was conducted in the area encompassed by the sewage treatment plant to the southwest of the project area. A portion of a large agricultural complex was recorded.

A surface survey conducted by ARCH of coastal lands (approximately 1000 acres) of the a*hupua'a* of Weliweli, Pā'ā, and Māhā'ulepū was conducted in 1974 (Ching, Palama, and Stauder 1974). Several important sites, specifically the Waiopili Heiau complex, were located. However, extensive bulldozing and stone robbing had destroyed most of the surface features, making spatial analysis impossible.

In 1977, reconnaissance was undertaken to locate an *'auwai* that was reputed to run from Waikomo Stream to the area of the Prince Kuhio Hotel (Bordner 1977), west of the current project area. A large *'auwai* was found, which corresponds to the major *'auwai* system assigned State Site # 50-30-10-1934. A portion of an agricultural system to the west of the present study area was also described. In its lower section, the *'auwai* is built up into an aqueduct several feet above the surrounding ground surface; at present, this is a unique feature in the State of Hawai'i. Again, bulldozing and historic construction has damaged sections of the agricultural system, but there is no doubt that these sites are similar to those found in the study area.

Cultural Surveys Hawai'i, Inc. (CSH) conducted an archaeological survey for the proposed Kōloa-Po'ipū Bypass Road project (Hammatt et al. 1985), just to the east of the current project area. Archaeological work was completed, however the plans for the road alignment were abandoned and a completed survey report was never submitted to SHPD. A total of 47 previously identified and undocumented sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt et al. (1978). Ten sites, including enclosures and C-shaped structures, were selected for subsurface testing. "The testing showed only sparse evidence of occupation with no apparent cultural stratification" (Hammatt et al. 1985). The best examples of sites were recommended for either preservation or data recovery.

Francis Ching (1983) conducted a reconnaissance survey, and an historical investigation of 230+ acres of Alexander and Baldwin lands within the *ahupua'a* of Kōloa (west Kōloa) and Lāwa'i. According to Ching, three-fourths of the study area was bulldozed, with many rocks re-located, however, remnants of walls, *lo'i* (wetland cultivation), '*auwai* (irrigation ditch) flumes, terraces, and an historic railroad berm were still discernable. These remnants are evidence of the great expanse of the Kōloa Field System.

James Landrum (1984), of the Bishop Museum, conducted a reconnaissance survey of a 200+ acre portion of Kukuiʻula. Landrum recognized that his survey area was once part of an extensive irrigated agricultural complex developed in the prehistoric period with superimposed historic-era occupation (Landrum 1984:24).

Hallett Hammatt, Douglas Borthwick, David Shideler, and Mark Stride (Hammatt *et al.* 1988) conducted an archaeological inventory survey in the 1000-acre proposed Kukuiʻula Bay Planned Community, west of the current project area. Fifty-eight archaeological sites were recorded, many associated with the Kōloa Field System. Two to three *heiau* were found, possibly including the remains of Kamaloula Heiau.

William Kikuchi (1988) conducted a reconnaissance level survey of the former Paʻanau Sugar Camp, northwest of the present project area. The camp was located just *makai* (south) of the present day Kōloa Elementary School. The survey recorded a number of cement foundations, ditches, and portable historic artifacts. Kikuchi states that archaeologically the site is interesting because it contains remnants of an early (1910-1950) plantation camp, even though the vast majority of its structures have been destroyed or removed.

Hallett Hammatt (1990) conducted an inventory survey of a 4.7-acre parcel at the west end of Paʻanau Road near Kōloa town, northwest of the present project area. The historical segment of this report indicates the previous existence of the Paʻanau Camp, and a railroad and ʻ*auwai* irrigation ditch which traversed the study area. However, the survey revealed the absence of any traces of pertinent features.

Hallett H. Hammatt (1991) carried out an archaeological reconnaissance for a proposed waterline stream crossing of Pōʻeleʻele Stream, north of Kōloa town, a significant distance to the north of the present project area. He noted extensive modern land modification and no significant findings.

Hallett H. Hammatt (1992a) carried out an Archaeological Inventory Survey of a 3.8 acre property at Kīahuna, (TMK 2-8:014-026), but the entire parcel had been previously graded and there were no significant findings. This project is bounded by Poʻipū Road on the south and is southwest of the current project area.

Hallett H. Hammatt (1992b) carried out an Archaeological Reconnaissance of the Poʻipū Road and Lāwaʻi Road Junction near the mouth of Waikomo Stream*,* west of the current project area, but again there were no significant findings, owing to prior land disturbance.

Hallett H. Hammatt, Gerald Ida, and William Folk (Hammatt *et al*. 1993a) conducted an inventory survey, with limited subsurface testing, of 7.6 ac. (TMK 2-8-14:30) in east Kōloa, west of the present project area. This parcel is north of Poʻipū Road and south of the Old Railroad Grade. Site 3758, a house platform or possible *heiau*, was re-mapped, and three new sites habitation/agricultural complexes were recorded. According to Hammatt *et al.* (1993:21), these sites are remnants of traditional ʻ*auwai*, walls, fields, enclosures and habitation platforms, and appear to be a part of the larger Kōloa Field System, which encompassed over 1000 acres.

Hallett Hammatt, Gerald Ida, William Folk, David Shideler and Brian Collin (Hammatt *et al.* 1993b) conducted an assessment survey, subsurface testing and monitoring at Poʻipū Beach Park in the *ahupuaʻa* of Kōloa, *makai* (south) of the present project area. Wave action during Hurricane ʻIniki in 1992 had exposed a cultural layer (Site 50-30-10-745) which needed to be preserved and monitored during the reconstruction and restoration of the park. Auger testing (Hammatt *et al.* 1993b:11) revealed charcoal, and both traditional and historic midden and artifacts (*i.e.* basalt flakes and fragments, nails, glass, *kukui* shells, and mollusk shells). An historic cemetery (State Site 50-30-10-1871), located in the middle of Poʻipū Beach Park, and other sections of the buried cultural layer beneath the park, were also monitored during the removal of several cement slabs, remnants of a pavilion, picnic tables, and barbecues. Three radiocarbon dates were determined for this layer: the earliest was A.D. 1282-1414 and latest ranged from A.D. 1678-1940 (*ibid*:52). The rich cultural layer, supported by radiocarbon dating, indicates that this shoreline occupation is contemporaneous with the development of the Kōloa Field System. This cultural layer is the "single largest coastal beach deposit in the *ahupuaʻa*...of Kōloa" (Hammatt *et al.* 1993b:65, 66) and greatly contributes to the information bank regarding the cultural development of the Kōloa district.

Victoria Creed, Gerald Ida and Hallett H. Hammatt (1995) reported on an inventory survey within a 1.4-mile corridor along the *mauka* (inland) side of Poʻipū Road (TMK 2-8-15, 16, 17 & 18) in the *ahupuaʻa* of Kōloa and Weliweli, south and east of the present project area. Three sites, including enclosures, a terrace, and the Kōloa-Weliweli boundary wall, survived previous bulldozing of the area and were understood as components of the Kōloa Field System.

Kristina Bushnell and Hallett H. Hammatt (1996) carried out an archaeological investigation of ʻŌmao Bridge in ʻŌmao Homestead, a significant distance *mauka* (northwest) of the current project area. The only objects of historical interest noted were the existing bridge and features associated with an old railroad.

Hallett Hammatt, Victoria Creed, and Gerald Ida (1996) conducted an assessment survey of an exposed cultural layer in undisturbed sand deposits at Waiohai Hotel, *makai* (south) of the current project area. This layer was disturbed by high wave action during Hurricane ʻIniki, which completely destroyed the associated reconstructed Kiha Houna Heiau (Site 50-30-10-80). Three charcoal samples from this layer were dated to A.D. 1430-1950. The exposed cultural layer supports the potential existence of widespread intact cultural areas along the general shoreline (Hammatt *et al.* 1996:36, 39).

Nancy McMahon, (April 1996) at the time an independent archaeological consultant, completed a reconnaissance survey southwest of the current project area. The purpose of the survey of TMK 2-08-16:3 (8.444 acres), part of the Sheraton Kauaʻi Resort, was to report on damage caused by Hurricane ʻIniki. No surface sites or cultural deposits were reported. She noted a sandy deposit up to the foundations of the buildings on the eastern side of the project area near Lae o Kamilo. She suggested that the remnants of beach dunes could still exist and recommended monitoring of any construction in this area in case historic sites, including human burials, were uncovered.

Beginning in December of 1996, reconstruction of areas damaged by the hurricane began at the Sheraton Kauaʻi Hotel (McMahon pers. communication). Excavations took place to construct new buildings on new concrete pads. An intact cultural layer, designated Layer III was uncovered. The cultural layer, Layer III, was a dark sandy layer. After grading of one Pad area was complete, human skeletal remains were found in the excavated material. During monitoring of the rest of the project, a total of ten subsurface features (Features B-K) were discovered. Six were fire pits, one was a stain, one was a concentration of fire-cracked rocks, one was a C-shaped structure, and one was a pig skeleton. Eight burials were also uncovered within Layer III. Six charcoal samples were submitted for radiocarbon age determination for Layer III. These ranged from 20+/- 70 BP (before present) to 540+/- 60 BP, indicating that the earliest possible date for the features was A.D. 1400.

Gerald Ida, Victoria Creed and Hallett H. Hammatt 1997) conducted a reconnaissance survey on a 1.2 mile corridor of a proposed bypass road within the *ahupuaʻa* of Kōloa and Weliweli (TMK 2-8-02:3, 2-8-03:1, 2-8-04:1, 2-8-05:2) that had previously been bulldozed. This road extended from an existing bypass road at the coast to north of Kōloa town, north of the present project area. This survey did not reveal any archaeological sites, and further study was not recommended.

Cultural Surveys Hawaiʻi, Inc. (Hammatt, Chiogioji, Shideler, Borthwick, McDermott and Masterson, 1998) reported on data recovery of the Kukuiʻula Planned Community Project Phase 1 area encompassing approximately 219 acres (Hammatt *et al*. 1998), west of the current project area. The project included excavations at 20 different sites, which encompassed 64 individual features. There were a total of 212 excavation units (212 square meters) and 19 backhoe trenches (only 14 backhoe trenches were chosen for study). Large quantities of midden (approx. 23.7 kilograms) and artifacts (10,635 items) were recovered and are reported on. The artifacts include a wide range of types with both indigenous (2,592 items) and historic (8,043 items) represented. Radiocarbon (C14) dates ranged from ca. A.D. 1050 onward. The earliest date came from the habitation/burial cave Site 50-30-10-1927A. In addition to the habitation sites and features dated, seven dating samples from agricultural features were also analyzed.

Cultural Surveys Hawaiʻi, Inc. (Hammatt, Bushnell, Ida, Chiogioji, Creed and Shideler 1999) reported on data recovery work just *makai* and southwest of Kōloa Town on the west side of Waikomo Stream in the northeastern portion of the Kukuiʻula Planned Community Phase II Area (Hammatt *et al.* 1999), northwest of the current project area. The study area is comprised of approximately 33 acres and has been used as a buffer zone between cane lands/pastures and the residential lots bordering Poʻipū Road. While some ten land commission awards lie partially or entirely within the Kukuiʻula project area, most of these properties were bulldozed in the course of sugar cane cultivation. There were, however, areas, which appeared undisturbed by sugar cane cultivation or heavy machinery. Excavations were conducted within five archaeological sites (13 features). These excavations yielded 264.8 grams of midden; 53 indigenous artifacts (including 43 volcanic glass flakes, 9 basalt flakes, and one coral manuport); and 877 late-historic artifacts (*e.g.* glass, metal, ceramics, plastic, leather, and slate). Twelve charcoal samples were dated, and ranged from A.D. 1250-1410 to A.D. 1800 to present.

Jesse Yorck, David Shideler, and Hallett Hammatt (2002) conducted an inventory survey of three proposed well sites near Pīwai Reservoir north of ʻŌmao Homesteads, located a significant distance northwest of the current project area. No archaeological sites were identified in the project area or vicinity.

In 2003, an archaeological survey was conducted along the coast in the Sheraton Kaua‘i Hotel property, southwest of the current project area (O’Hare *et al.* 2003). Salt pans, abraded areas, and possible bait cups were recorded along the rocky coast; these may correspond to Bennett’s Site 76 “Salt pans, east of Waikomo stream along the shore” (Bennett 1931:98). Five features were noted in the interior section of the project area, two platforms, one mound, one terraced area, and one enclosure. The two platforms were later partially dismantled to test for burials. No human remains or any other cultural materials were recovered from the features.

C. Previous Archaeological Studies Specific to the Project Area

Akihiko Sinoto (1975) conducted a reconnaissance survey of 400+ acres of Knudsen Trust Lands at Kōloa including a portion of the current project area. He recorded several features and suggested they were the northern remnants of Bennett’s Sites 78, 79, 85 and 86. Large numbers of sites were located, with the concentration of both habitation and agricultural features along the southern portion of the study area, from the sewage treatment plant to the Weliweli subdivision. Sinoto recommended more intensive survey and subsurface testing for the parcel.

Archaeological sites in the project area were located and described as part of the archaeological survey in support of the proposed Kīahuna Golf Village project by the Archaeological Research Center Hawai‘i (ARCH) (Hammatt et al. 1978). An archaeological report was completed, however its status with the State Historic Preservation Division (SHPD) as an accepted inventory survey report is unclear. A total of 583 features were recorded in a total surveyed area of 460 acres. The current project area was covered as the *makai* (southern) portion of the Kīahuna survey area designated Area C. Sites were located and described with no subsurface testing. Both habitation and agricultural sites were located in the Kīahuna Golf Village project area, including stone enclosures, platforms, *‘auwai* (irrigation ditches), and terraced plots. Selective preservation or data recovery was recommended for sites in the Kīahuna Golf Village project area as “they represent a highly significant cultural resource of substantial value for archaeological research and interpretation” (Hammatt et al. 1978).

Hallett H. Hammatt, William Folk, and Mark Stride (1991) conducted an archaeological inventory survey in support of the proposed Po‘ipūlani Golf Course project (Hammatt et al. 1991), which included the previously surveyed Kīahuna Golf Village project (Hammatt et al.1978) and the *makai* (southern) portion of the current project area. This report was reviewed and accepted by SHPD along with a data recovery and preservation plan for the property (Hammatt 1991). A total of 75 sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt et al. (1978). Sites previously identified in the Kīahuna Golf Village and Kōloa-Po‘ipū Bypass Road projects were relocated and assigned state site numbers. Preservation was recommended for “major sites,” and “all other sites which cannot be incorporated into the development should be subjected to a program of data recovery including subsurface testing and excavation” (Hammatt et al. 1991). As shown in figure 6 and table 2, both habitation and agricultural sites were located in the vicinity of the current project area, including stone enclosures, platforms, mounds, and *‘auwai* (irrigation ditches).

In 2003, the current project area was subjected to a field inspection by Tulchin and Hammatt. Pedestrian inspection of the project area was accomplished by following along the borders of disturbed areas including large boulder piles, fenced enclosures, and bulldozed roads using GPS.

Existing sites in the vicinity of the various disturbed areas were located and their condition assessed. Sites within the interior of the GPS surveyed boundaries of disturbed areas were assumed to have either been covered or destroyed. The collected GPS data was overlain on archaeological site maps associated with the Kīahuna Golf Village project (Hammatt et al. 1978) and the Kōloa-Poʻipū Bypass Road project (Hammatt et al. 1985).

Table 1. Previous archaeology of Kōloa and vicinity

NAME	YEAR	LOCATION	STUDY TYPE
Bennett	1931	Kukui'ula Valley, Prince Kūhiō Park	General Survey
Kikuchi	1963	Kona District	General Survey
Kikuchi	1973	Hawaiian Fishponds	General Survey
Palama and Stauder	1973	Cane Haul Road-Kōloa Mill	Reconnaissance Survey
Sinoto	1975	Knudsen Trust Lands	Reconnaissance Survey
Bordner	1977	Kukui'ula *'auwai*, Site 50-39-10-1934	Reconnaissance Survey
Hammatt, Bordner and Tomonari-Tuggle	1978	Kīahuna Complex	General Survey
Connolly	1982	Kōloa-Po'ipū Bypass Road	Reconnaissance Survey
Ching	1983	Kukui'ula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Landrum	1984	Kukui'ula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Hammatt, Borthwick and Shideler	1985	Kōloa-Po'ipū Bypass Road	Survey and Subsurface Testing
Kikuchi	1985	Shoreline Improvements, Waiohai Hotel, Kiha Houna Heiau	Reconstruction
Kikuchi	1988	Pa'anau Sugar Camp	Reconnaissance Survey
Hammatt *et al*. (Hammatt, Borthwick, Shideler, and Stride)	1988	Kukui'ula Bay Planned Community	Inventory Survey
McMahon	1989	Kauaʻi Fishponds	General Survey
Hammatt	1990	Pa'anau Housing Project	Inventory Survey
Hammatt	1991	Pō'ele'ele Stream – Waterline crossing	Archaeological Reconnaissance
Hammatt, Folk, and Stride	1991	Po'ipūlani Golf Course	Inventory Survey
Hammatt	1992a	Kīahuna	Inventory Survey
Hammatt	1992b	Po'ipū Road and Lāwa'i Road Junction	Archaeological Reconnaissance

NAME	YEAR	LOCATION	STUDY TYPE
Hammatt, Ida and Folk	1993a	Po’ipū Road 7.6-acre Parcel	Inventory Survey
Hammatt *et al.* (Hammatt, Ida, Folk, Shideler, and Colin)	1993b	Po’ipū Beach Park	Subsurface Testing and Monitoring
Creed, Ida and Hammatt	1995	Po’ipū Road	Inventory Survey
Bushnell and Hammatt	1996	‘Ōmao Bridge, ‘Ōmao Homestead	Archaeological Investigation
Hammatt, Creed, and Ida	1996	Waiohai Resort	Assessment Survey
McMahon	1996	Sheraton Kaua‘i Hotel	Reconnaissance Survey
Ida, Creed, and Hammatt	1997	Po’ipū Bypass Road	Inventory Survey
Hammatt *et al.*	1998	Kukui’ula Planned Community Phase I	Data Recovery
Hammatt *et al.*	1999	Kukui’ula Planned Community Phase II	Data Recovery
Yorck, Shideler, and Hammatt	2002	Kaumuali‘i Highway, Alexander and Baldwin Properties	Inventory Survey
Tulchin and Hammatt	2003	Eric Knudsen Trust Lands	Field inspection

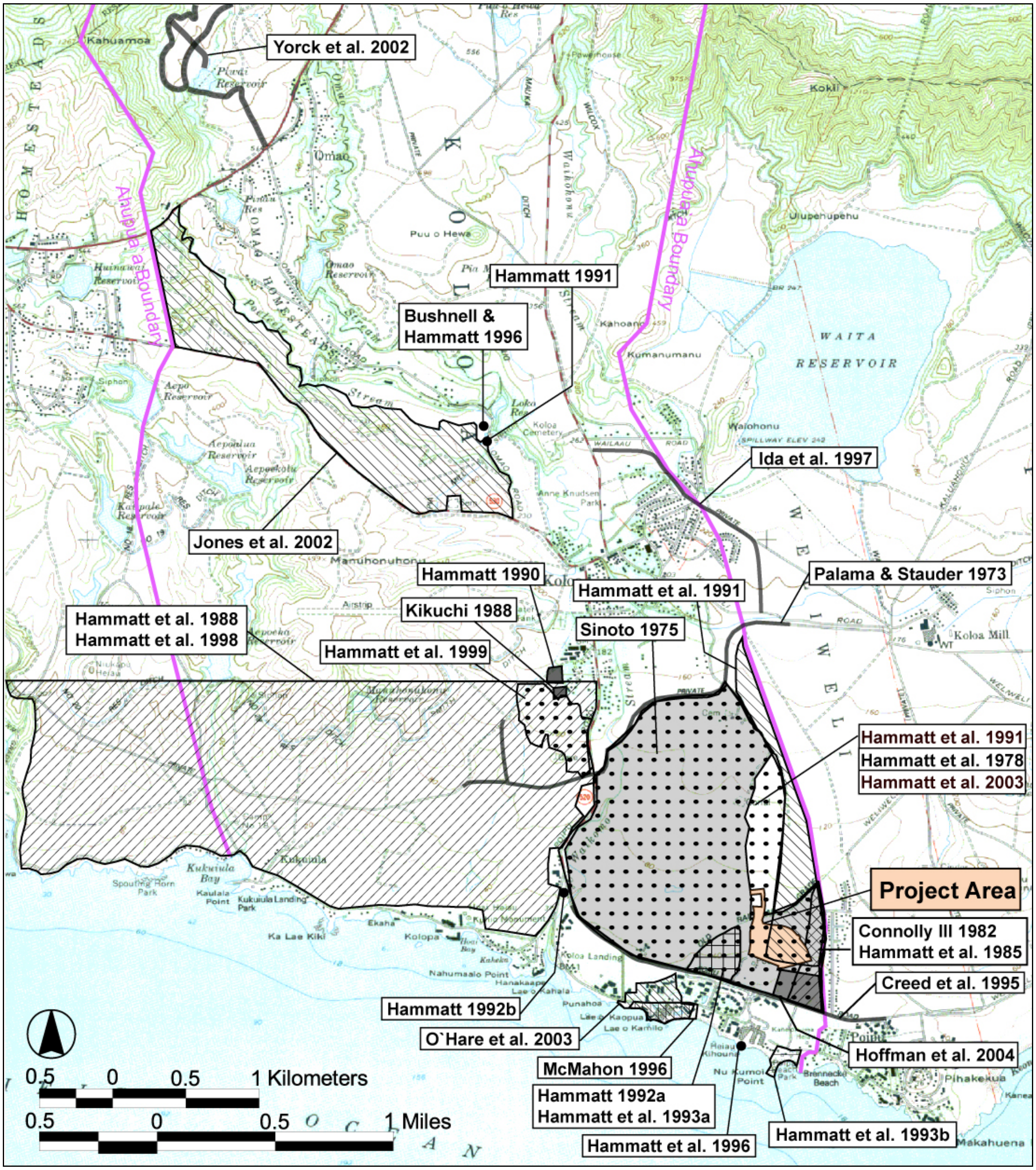

Figure 4. U.S. Geological Survey map, Kōloa quad., showing project area and locations of previous archaeological studies

D. Settlement Model Based on Results of Previous Archaeological Work

From previous archaeological studies and historic accounts it appears that habitation and intensive irrigated agriculture were widespread in central and coastal Kōloa utilizing the opportunity to develop an extensive irrigated complex (the Kōloa Field System) off of Waikomo Stream. As the Judd (1935) account asserts, it is likely that low inland areas were used for less intensive cultivation of patches of sweet potato, *pia*, and *wauke* and the gathering of *hala*, *kukui* and other resources. The coastal portion would be a focus for permanent habitation, collection of marine resources, ceremonial activities, and burials.

Chronological analysis from Kōloa, and the two neighboring *ahupua'a*, Pa'a and Weliweli, suggests an early initial occupation within the Pa'a Ahupua'a of circa A.D. 535 (Walker and Rosendahl, 1990:131). No coinciding early dates have been found within Kōloa Ahupua'a, probably due to vagaries of sampling since most of the shoreline area of Kōloa has been heavily impacted by commercial, residential, and resort development. Initial occupation probably was characterized by temporary and/or recurrent occupation. From A.D. 600-1400, settlements in the Kōloa area were still limited to the coast. By A.D. 1040, lava tubes were used for burial and temporary habitation in the inland areas of Kōloa (Hammatt *et al.* 1999:7).

Beginning possibly as early as 1450, the 'Kōloa Field System' was planned and built on the shallow lava soils to the east and west of Waikomo Stream. The Kōloa Field System is characterized as a network of fields of both irrigated and dryland crops, built mainly upon one stream system, that of Waikomo Stream, adapted into an inverted tree model with smaller branches leading off larger branches; with dispersed housing and field shelters among the fields, particularly at junctions of *'auwai*, the whole contained within the entire *makai* portion of the *ahupua'a* of Kōloa stretching east and west to the *ahupua'a* boundaries and possibly into Weliweli Ahupua'a.

The field system, with associated clusters of permanent extended family habitations, was in place by the middle of the 16th century and was certainly expanded and intensified continuously from that time. Long *'auwai* were constructed along the tops of topographic high points formed by northeast to southwest oriented Kōloa lava flows. These *'auwai* extended all the way to the sea. Habitation sites, including small house platforms, enclosures and L-shaped shelters were built in rocky bluff areas which occupied high points in the landscape and were therefore close to *'auwai*, which typically ran along the side of these bluffs. From A.D. 1650-1795, the Hawaiian Islands were typified by the development of large residential communal residences, religious structures and an intensification of agriculture. Large *heiau* in Kōloa may date to this period.

There are fifteen named *heiau* and one named fishing shrine for the *ahupua'a* of Kōloa. Of these, at least four temples are *luakini* (for the chiefly class) - two of the *po'okanaka* (*heiau* built by high chiefs) class; five are associated with fishing; two are medicinal; one is agricultural; and, four are of unknown function.

IV. SITE DESCRIPTIONS

The following sites are in the vicinity of the current project area. The sites were first located, described, and assigned state site numbers as a part of the archaeological survey for the proposed Kīahuna Golf Village project (Hammatt et al. 1978) and the archaeological inventory survey for the proposed Poʻipūlani Golf Course project (Hammatt et al. 1991). The site descriptions are taken from the Hammatt et al. (1991) archaeological inventory survey. Figure 5 illustrates the locations of and recommendations for the sites in the vicinity of the current project area. Table 2 summarizes the sites; work previously completed at each site, and recommendations for each site.

SIHP Site #:	50-30-10-900
Site Type:	Platform, C-shape, and enclosure
Function:	Permanent habitation
Features (#):	3
Age:	Pre-contact Hawaiian

Description: This site is a roughly rectangular, permanent habitation platform of pre-historic age measuring 6.1x12.2 meters. The platform is a maximum of .8 meters high and is very well constructed. There are two paved areas on this platform. The southern area is paved with boulder slabs. The northern area is pebble paved and contains a rectangular stone-lined hearth. There are two associated features: one C-shaped structure adjacent to the north, the other a rectangular enclosure to the southwest. The C-shape measures 4.6x7.6 meters, with an interior area of 1.8x2.4 meters and maximum back wall height of 1.5 meters. The enclosure measures 3.7x4.6 meters with an interior area of 1.8x2.1 meters. The walls of the enclosure are well-faced and are a maximum of .8 meters high. This site, a possible *kauhale,* is probably associated with the large agricultural system (832) complex, which is approximately 15.2-18.3 meters to the west.

SIHP Site #:	50-30-10-901
Site Type:	Mounds and wall
Function:	Agriculture
Features (#):	2
Age:	Pre-contact Hawaiian

Description: Thus site is a pre-historic agricultural field system consisting of numerous small amorphous mounds and little soil pockets in an area of exposed *pahoehoe* bedrock. The mound field is surrounded by a wall .9 meters wide which ranges in height from .5-.8 meters and is constructed of loosely piled boulders. The wall encloses an area of 30.5 meters E/W by 30.5 meters N/S.

SIHP Site #: 50-30-10-906

Site Type: Mounds

Function: Agriculture

Features (#): 1

Age: Pre-contact Hawaiian

Description: This square mound is 1.5 meters high on the *makai*, or southeast corner, 2 meters square at the base, and 1.5 meters square at the top. It has a depression in the middle, possibly from rock or pot hunting. The site has well-faced sides, some uprights, some slabs lying flat, a few larger boulders, and cobble-sized rocks on the top. There are two 1 meter high round mounded agricultural walls 9 meters long oriented roughly N/S which appear to be forming a round elongated field. Agricultural mounds and amorphous rock pilings on bedrock are located to the south of the site. This is a pre-contact agricultural site.

SIHP Site #: 50-30-10-911

Site Type: Wall

Function: Shelter (possibly temporary)

Features (#): 1

Age: Pre-contact Hawaiian

Description: This site is a 2 meter long, roughly N/S running wall that was the back wall of a C-shape temporary habitation shelter or some other structure, the remainder of which has been bulldozed on the west side. The wall is .5 meter high and a maximum of 2 meters wide. The site is in poor condition. No midden or artifacts were observed. The site is estimated to be pre-contact.

SIHP Site #: 50-30-10-912

Site Type: C-shaped enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This site is a probable C-shape temporary habitation shelter which would have been open to the west before it was damaged. The maximum exterior dimensions at the present are 4 meters N/S by 3 meters E/W. It is built off and easterly sloping bluff. The interior maximum dimensions would have been 1.5 meters N/S by unknown distance E/S. The site is presently an island in the middle of bulldozing and is heavily damaged. No midden or artifacts were observed. This is a pre-contact site.

SIHP Site #: 50-30-10-913

Site Type: Agricultural complex

Function: Agriculture

Features (#): 6

Age: Pre-contact Hawaiian

Description: This is an agricultural complex consisting of 4-5 well-preserved terraced fields surrounded by well-constructed thick field walls. The entire complex measures approximately 61 meters E/W by 54.9 meters N/S. This is a remnant of a wet irrigated agricultural system which is fed by a well preserved *'auwai*. Site 913 *'auwai*, which enters from the NW, is easily visible as two parallel alignments coming downslope into the terraced fields. On the western side of the *'auwai*, as it enters the first field, is a large mound of piled rocks on top of which stands a habitation platform which is paved and level on the upper surface. The platform is sloping around the edges but the upper surface is paved with cobbles and pebbles. The south side of the platform is a well-preserved facing approximately 3 meters square on its upper surface and, including the sloped area, is approximately 4.6 meters square. The platform overlooks the *'auwai*, which is located to the east and downslope. The lower facing of the platform on the E side is the west wall of the *'auwai*. This platform is referred to as Feature A of site 913. There is a cupboard feature located 9.1 meters to the southwest of the platform that was built into large rocks as part of a thick field wall. The platform feature A is the only habitation feature identified within this agricultural complex. The bedrock bluff on which is stands has been heavily modified and in itself forms a terrace which stands 1.5-1.8 meters in elevation above the surrounding fields below. Some of the level terraced fields have rock mounds within them. There are water entries and exits still visible. As mentioned, the walls are massive, sometimes 2.4-3 meters thick, mostly core-filled, and are clearly well-developed terrace field walls. The *'auwai* which enters this site complex is traceable *mauka* for over 304 meters.

SIHP Site #: 50-30-10-917

Site Type: U-shaped mound

Function: Agriculture

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a U-shaped mound or rough platform measuring a maximum of 17.7 meters N/S and 10.4 meters E/W. The structure stands .5-.6 meters above the surrounding terrain and has no distinct facing. The top surface is roughly paved with small boulders with two areas of soil and loose rock, one at the west end and one at the south end. This is only a possible habitation feature and shows no visible artifacts or midden. It is estimated to be a pre-contact agricultural site.

SIHP Site #: 50-30-10-918

Site Type: Platform

Function: Permanent habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This site consists of a well-defined, rectangular, permanent habitation platform measuring 4.6x9.8 meters N/S and .5-.8 meters high. The edges are faced with boulders and the top surface is paved with boulder slabs, cobbles, and compacted soil at the south end. At the northern end of the platform is a crypt-like depression measuring .8 meters N/S by 2.4 meters E/W. Adjoining the main platform at the southwest end in another smaller platform measuring 5.5x3.7 meters E/W. This attached platform is .3 meters lower than the main platform and is more roughly paved with small boulders and cobbles. This platform stands approximately .3 meters high and contains soil at the north end. A wall measuring 5.2 meters long, 1.5 meters wide, and .9 meters high, runs N/S, northwest of the main platform. A few basalt flakes were observed on the surface of the main platform. This site is certain to be a focus of permanent habitation and probably contains a quantity of cultural material. It is judged to be a pre-contact site, with early post-contact usage based on comparisons to other similar features in Kōloa, west of Waikomo Stream. Sites 1944A and B in the Kukuiʻula project area are of comparable size and have a similar soil and pebble paving and were determined to have been early historic habitations. This site, based on this comparison, may be of a similar time period.

SIHP Site #: 50-30-10-921

Site Type: *ʻAuwai* section

Function: Agriculture

Features (#): 1

Age: Pre-contact with probable historic use

Description: This is a poorly preserved section of *ʻauwai* defined by a rock piling with a depression in the center. The depression in this section is .6 meters high and .8 meters wide. The *ʻauwai* is best preserved at this locality but is traceable for 42.7 meters north at 346° and south for about 30.5 meters at 155°. Over most of its length it has been filled in or modified by bulldozing activities. An L-shaped agricultural mound lies directly to the east of the *ʻauwai*. Because of bulldozing activities, on both ends of the site, it is not traceable beyond these points and cannot be projected to connect to other *ʻauwai* remnants. This is a pre-contact *ʻauwai* with probable historic use for sugar irrigation.

SIHP Site #: 50-30-10-947

Site Type: Railroad berm

Function: Transportation

Features (#): 1

Age: Historic

Description: The berm is constructed of stacked boulders with facing on both sides and a fill of smaller rocks and soil. At the southwest end the berm reaches the greatest height of 1.8 meters and is consistently 3 meters wide. At the far southwest end is a constructed inset for an *ʻauwai* water flow under the berm. As the berm traverses NE it gets progressively lower and there is collapse of the facings in some sections. At the NE end the berm is nearly level with the ground surface, maintaining a height of .9 meters or less. At one time, this railroad was used to haul cane from Weliweli and Paʻa to Kōloa Landing. A preserved section of the berm is visible on the west side of the Kīahuna Golf Course entry road.

SIHP Site #: 50-30-10-948

Site Type: Wall

Function: Field system/ Cattle wall

Features (#): 1

Age: Pre-contact Hawaiian with historic modifications

Description: This site is a large wall-enclosed field system in a relatively rock-free low-lying soil area. The enclosing wall surrounds an oval shaped area approximately 64 meters E/W by 128 meters N/S. The wall is a typical cattle wall measuring 1.5 meters high and .9 meters wide at the base. It is too high to be a field wall and is free-standing. There are 6 interior walls mostly running *mauka/makai*, which are .3-.6 meters high mounded terrace walls defining the field plots which average 3 meters wide and 9-18 meters long. In the center of the enclosed area is an *ʻauwai* section running northwest to southeast and traceable for 36.6 meters. A portion of this *ʻauwai* is raised above the surrounding terrain .6 meters. There are various internal enclosures that are described separately below. This site is a pre-contact field system with historic modifications, which include the addition of a cattle wall surrounding it.

SIHP Site #: 50-30-10-949

Site Type: Enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This site appears to be a temporary habitation site. The northwest and southeast corners are disturbed partially damaged, and the walls are partially disassembled. It is built on an eastward slope approximately 7.6 meters east of the western perimeter wall of site 948.

The enclosure measures internally 2.4 meters E/W with walls 1.2-1.5 meters high and .6-.9 meters wide. The interior is loose soil. The west wall abuts a terrace retaining wall. The site is in good condition. No midden or artifacts were observed. This site is independent of the surrounding cattle wall and is judged to be a part of the pre-contact field plots.

SIHP Site #: 50-30-10-950

Site Type: Enclosure

Function: probable animal pen

Features (#): 1

Age: Historic

Description: This site is 4.6x10.7 meters, with walls .9-1.5 meters high, .9 meters wide of well-faced stacked boulders; pebble and cobble paved interior, the boulder curbing in the northeast corner forms a rectangular .6x.9 meter feature; the east wall abuts enclosing walls of site –948, and the feature is in good condition. No artifacts or midden were observed. The entire interior of the structure is filled with sisal plants and the floor is raised .3-.6 meters above the exterior ground level. It is a probable animal pen and is judged to be of historic age because it is connected to the historic cattle wall surrounding the site. It is not considered a habitation site because no internal features appear to be present and because there is no occupational debris visible.

SIHP Site #: 50-30-10-951

Site Type: Enclosure

Function: Temporary habitation

Features (#): 1

Age: Historic

Description: This is a temporary habitation enclosure with the south wall built against the southwest side of the enclosing wall of site –948. The interior of the enclosure measures 3x4.6 meters; the walls are .9 meters high, .6 meters wide, and constructed of stacked boulders. It has a rocky floor, shows signs of some disturbance, and shows no midden or artifacts. Because it incorporates the cattle wall (site -948), it is judged to be of historic age.

SIHP Site #: 50-30-10-952

Site Type: Platform

Function: Permanent habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This site is a permanent habitation platform located west of site –948 and along the edge of a NW to SE oriented ‘*auwai* section. The platform is roughly paved with loose boulders and cobbles and stands .6-1.2 meters above the surrounding terrain. There is rough facing on the NW, SW, and SE sides. Near the center of the platform is a collapsed slab-lined cupboard .9 meters long, .6 meters wide, and .5 meters deep. No midden or artifacts were observed. This is judged to be a pre-contact permanent habitation based on the size and formality of the structure.

SIHP Site #: 50-30-10-953

Site Type: 2- level platform

Function: Burial/Habitation

Features (#): 2

Age: Pre-contact Hawaiian

Description: This site consists of a 2-level platform. The upper level has boulder facings on all four sides and is 1.2 meters high. The platform measures 3.7 meters N/S and 4.6 meters E/W. There is a depression on the surface approximately .6 meters in diameter. On the east and south sides, there is a level .6 meters lower bordering the platform center. The southwest corner is collapsed. This monumental platform is faced with .3-.6 square slab boulders placed upright. At the south edge of the platform is a bedrock outcropping in a terrace formation, semicircular, approximately 1.5-1.8 meters maximum distance from the south side of the platform. No midden or artifacts were observed on the surface of the high platform.

A lower platform, which is attached to the high platform on the west side, is 3.7 meters square and is .5 meters high at the southwest corner. At the western boundary of the lower platform is a bulldozed tailing of a waterline and approximately 12.2 meters further west is the railroad berm. No artifacts or midden were observed on the lower platform. South of the monumental platform is an area of boulders, delineated on the west side by a wall running N/S and some irregular soil terraces, with a maximum size of 1.8 meters square. The high platform is considered a probable burial site. It is high and formally faced and unpaved. Both of the platforms are considered to be pre-contact. The lower platform is evaluated as a permanent habitation site.

SIHP Site #: 50-30-10-954

Site Type: Enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a temporary habitation enclosure with external dimensions of 6.1 meters and a roughly oval shape. The walls are .9-1.5 meters high and 1.2-1.5 meters wide of stacked boulders. The center of the enclosure contains a .6-meter deep depression. An *'auwai* branch section abuts the structure on the southwest and southeast sides. No artifacts or midden were observed. The structure is judged to be pre-contact and is partly disturbed by surrounding bulldozing.

SIHP Site #: 50-30-10-955

Site Type: Mound

Function: Agriculture

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact agricultural mound located 15.2 meters to the east of site 954. The mound measures 2.4 meters in diameter and has a maximum height of .6 meters. There are clearly defined facings along the edges. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-956

Site Type: C-shaped enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact C-shaped temporary shelter measuring 3 meters E/W by 2.4 meters N/S. There are walls .9-1.5 meters high, 1.2 meters wide of stacked boulders. The structure is horseshoe-shaped with pebble paved floor. A cupboard .5 meters in diameter with capstones missing is built into the north wall at floor level. There is a natural level area to the southwest, 4.6 by 3.7 meters, possibly paved. There is a large upright at the west end of the level area. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-957

Site Type: C-shaped enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact C-shaped, temporary habitation structure 2.1 meters in diameter open to the southwest. The back wall is 1.2 meters high, 1.2 meters wide and is built of stacked boulders. There is a paved platform 1.8 meters square with a collapsed storage pit, .9 by .6 by .9 meters, attached to the southwest. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-958

Site Type: Enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact enclosure for temporary habitation, 1.8 meters N/S by 2.4 meters E/W, built of stacked boulders with walls .9 meters high and 1.2 meters wide. A .5 meter high wall extends northwestward from the west corner of this structure for 6.1 meters. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-959

Site Type: C-shaped enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact C-shaped, temporary shelter open to the southeast. The structure exterior is 3 meters in diameter, with a back wall .9 meters high and 1.2 meters wide. There is a rocky floor and a cupboard .9 meters in diameter built into the southeast wall. The cupboard is lined with uprights with a capstone cover in place. The site is in a good state of preservation. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-960

Site Type: Enclosures

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This site consists of two adjoining oval-shaped structures open to the west and located in an area of agricultural mounds and small cleared areas. The structures, both of which are pre-contact, C-shaped temporary habitation features, measure 3 meters long by 1.8-2.4 meters wide, with walls 9 meters high. Upright slabs form the interior facing on the east side. A low wall .5 meters high and .9 meters wide runs to the south and west for 18.3 meters and connects to site 961. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-961

Site Type: C-shaped Enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a poorly preserved remnant of a pre-contact, C-shaped temporary habitation shelter open to the west and measuring 3 meters N/S by 1.8 meters E/W. Built into the wall is a .6 by 1.2 meters cupboard .5 meters deep. The structure is partly collapsed. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-962

Site Type: Enclosure

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact rectangular temporary habitation enclosure measuring 3 meters NW/SE by 2.4 meters NE/SW. The walls are .5 meters high and .9 meters wide. The opening is to the southeast and the interior is rocky. No midden or artifacts were observed on the surface.

SIHP Site #: 50-30-10-963

Site Type: Enclosure

Function: Agriculture

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact agricultural enclosure defined by a circular wall .5 meters high and forming a circle 13.7 meters in diameter. The interior of the enclosure is rocky and contains 2 low rock clearance mounds measuring .5 meters high and 1.2 meters in diameter.

SIHP Site #: 50-30-10-965

Site Type: 2 adjoining C-shaped enclosures and wall

Function: Temporary habitation

Features (#): 1

Age: Pre-contact Hawaiian

Description: This is a pre-contact C-shaped, temporary shelter open to the west with an interior diameter of 1.8 meters. The walls are .6 meters high and .9 meters wide and are constructed of piled boulders. There is a .9-meter square, .5-meter deep cupboard with fallen capstones in the south wall. A low agricultural wall .9 meters wide and 15.2 meters long curves to the south and west. This wall defines the planting area adjacent to the c-shape to the southwest.

SIHP Site #: 50-30-10-966

Site Type: Field system

Function: Agricultural

Features (#): 1

Age: Pre-contact Hawaiian with historic use

Description: This is an agricultural site enclosed by a cattle wall similar to site –948. The enclosing wall is well constructed, measuring 1.5 meters high and .9 meters wide at the base. In the interior are well-defined terraces bordering wet irrigated field plots. In the northeast corner is a .6-.9 meter high, 6.1-meter wide, curved, core-filled wall, which defines a *lo'i*. A well preserved *'auwai* enters from the northwest and continues through the entire site. This *'auwai* is the main source of water for the entire site and has a 9 meter wide channel in the center. It is defined by rocky parallel mounds. A branch of this *'auwai* feeds into the fields on the center of the enclosure. Another *'auwai*, which is less well defined, enters the enclosure from the northeast but is not traceable northward. The main focus of habitation for this site is *makai* and outside of the project area. This site encompasses pre-contact field walls in the interior but was modified in historic tomes with the additional of a surrounding cattle wall, which encloses the fields. It is a pre-contact system with historic use.

SIHP Site #:	50-30-10-967
Site Type:	C-shaped enclosure
Function:	Temporary habitation
Features (#):	1
Age:	Pre-contact Hawaiian

Description: This is a pre-contact, C-shaped temporary habitation shelter within the agricultural complex (site –966) and measures 3x1.8 meters E/W. It is open to the southeast. The back wall is 1.2 meters high and 1.5 meters wide at the base. The interior is rocky with some collapse. No midden or artifacts were observed.

SIHP Site #:	50-30-10-971
Site Type:	*'Auwai* section
Function:	Agriculture
Features (#):	1
Age:	Pre-contact Hawaiian

Description: This is a short *'auwai* section which runs west of site –954 and is traceable in a NW/SE direction for 21 meters. The *'auwai* is a .9-meter wide depression, .3 meters deep, and is bordered by low rock mounds on either side. The terminal points are both bulldozed and the *'auwai* is not traceable to any field system. It may have fed site –948 fields at the north end. It is of pre-contact construction with probable historic use for sugar. A branch of this *'auwai* extends along the southwest side of site –954 for 12 meters in a northeast direction.

SIHP Site #:	50-30-10-972
Site Type:	*'Auwai* section
Function:	Agriculture
Features (#):	1
Age:	Pre-contact Hawaiian/possible historic use

Description: This is a short *'auwai* section traceable for 30 meters in a N/S direction. It is entirely bulldozed at both ends. The depression is 1.2 meters wide, .3 meters deep, with rough rock pilings on both sides. This is a pre-contact site which may have been used in historic times for sugar irrigation.

SIHP Site #:	50-30-10-992
Site Type:	Roadway
Function:	Transportation
Features (#):	1
Age:	Historic

Description: Hapa road is a single lane unpaved road connecting Kōloa Town to the beach road (Po'ipū). The road is marked by a stacked boulder wall on both sides. The *makai* 15-18 meters has been reconstructed with mortar and stands 1.3 meters high with mortared interior. This reconstruction was in conjunction with the building, which now serves as a tourist information booth. There is a 6-meter gap in the wall for the parking lot and the original wall alignment continues northward. In the *makai* section of the property north of the landscaped area, the Hapa Road wall has been reduced by rock robbing to a height of 30-40 cm. or less. In some areas the wall is reduced to a loose alignment of boulders, one boulder high. Along its length, the original alignment of the wall is still traceable even though the bulk of the rocks are gone. The condition continues up to the *mauka* 30-60 meters of the property where the wall progressively improves in condition. At the *mauka* end, the wall is 1 meter wide and stands 1 to 1.2 meters in height. Much of the wall is of core-filled construction.

A brief inspection of historic maps gives some insight into the history and age of Hapa Road and its associated walls. Hapa Road is at least 100 years old. It appears on the Monsarrat Map of 1891. The road probably dates back to the 1850s when the Catholic Church was built *makai* of Kōloa Town on the west side of the road and probably predated this period as a *mauka/makai* trail. The road shows on all maps postdating 1891, including sugar field maps at the Kōloa Sugar Company. Because the rocky lands on either side of the road were used for cattle grazing, the walls were necessitated as pasture boundaries and to allow driving of cattle along the road during the early part of this century.

This wall, which lies within a few feet of the western property boundary, has been badly damaged in the last 25 years but is certainly over 50 years old and is an integral part of a road which is known to be over 100 years old. The wall, which is significant as an excellent example of a site type, should be protected.

A. Summary and Significance

Sites were evaluated for significance according to the broad criteria established for the National and State Registers. The five criteria are:

A Site reflects major trends or events in the history of the state or nation.

B Site is associated with the lives of persons significant in our past.

C Site is an excellent example of a site type.

D Site may be likely to yield information important in prehistory or history.

E Site has cultural significance; probable religious structures and/or burials present.

Table 2. Summary of sites in vicinity of project area, work completed, and recommendations (note: the prefix for all state site numbers is 50-30-10)

SIHP Site #	Significance	Nature of Site	Posited Function	Work Accomplished	Recommendation
-900	C, D	Platform, C-shape, and enclosure	Permanent habitation	Surveyed, mapped (1985)	Preservation with interpretation
-901	D	Mounds and wall	Agriculture	Surveyed (1985)	Data Recovery
-906	NLS	Mounds	Agriculture	Surveyed (1990)	No further work
-913	C, D	Agricultural complex	Agriculture	Surveyed, mapped (1990)	Preservation with interpretation
-917	D	U-shaped mound	Agriculture	Surveyed, mapped (1990)	Data Recovery
-918	D	Platform	Permanent habitation	Surveyed, mapped (1990)	Data Recovery
-921	D	*'Auwai* section	Agriculture	Surveyed, mapped (1990)	Data Recovery
-947	C, D	Railroad berm	Transporta-tion	Surveyed, mapped (1990)	Preservation with interpretation
-948	C, D	Wall	Field system/ Cattle wall	Surveyed (1978), resurveyed (1990)	Data Recovery
-949	D	Enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-950	D	Enclosure	Probable animal pen	Surveyed (1978), resurveyed (1990)	Data Recovery
-951	D	Enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-952	D	Platform	Permanent habitation	Surveyed (1978), resurveyed (1990)	Data Recovery

SIHP Site #	Significance	Nature of Site	Posited Function	Work Accomplished	Recommendation
-953	D, E	2- level platform	Burial/ Habitation	Surveyed (1978), resurveyed (1990)	Preservation of burial
-954	D	Enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-955	D	Mound	Agriculture	Surveyed (1978), resurveyed (1990)	Data Recovery
-956	D	C-shaped enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-957	D	C-shaped enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-958	D	Enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-959	D	C-shaped enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-960	D	Enclosures	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-961	D	C-shaped Enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-962	D	Enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-963	NLS	Enclosure	Agriculture	Surveyed (1978), resurveyed (1990)	No further work

SIHP Site #	Significance	Nature of Site	Posited Function	Work Accomplished	Recommendation
-965	D	2 adjoining C-shaped enclosures and wall	Temporary habitation	Surveyed (1978), resurveyed (1990)	Data Recovery
-966	C, D	Field system	Agriculture	Surveyed (1978), resurveyed (1990)	Preservation with interpretation
-967	D	C-shaped enclosure	Temporary habitation	Surveyed (1978), resurveyed (1990)	Preservation for information content
-971	D	*‘Auwai* section	Agriculture	Surveyed (1978), mapped (1990)	Data Recovery
-972	D	*‘Auwai* section	Agriculture	Surveyed (1978), mapped (1990)	Data Recovery
-992	C	Hapa Road	Transporta-tion	Surveyed (1992), Mapped (1992)	Preservation

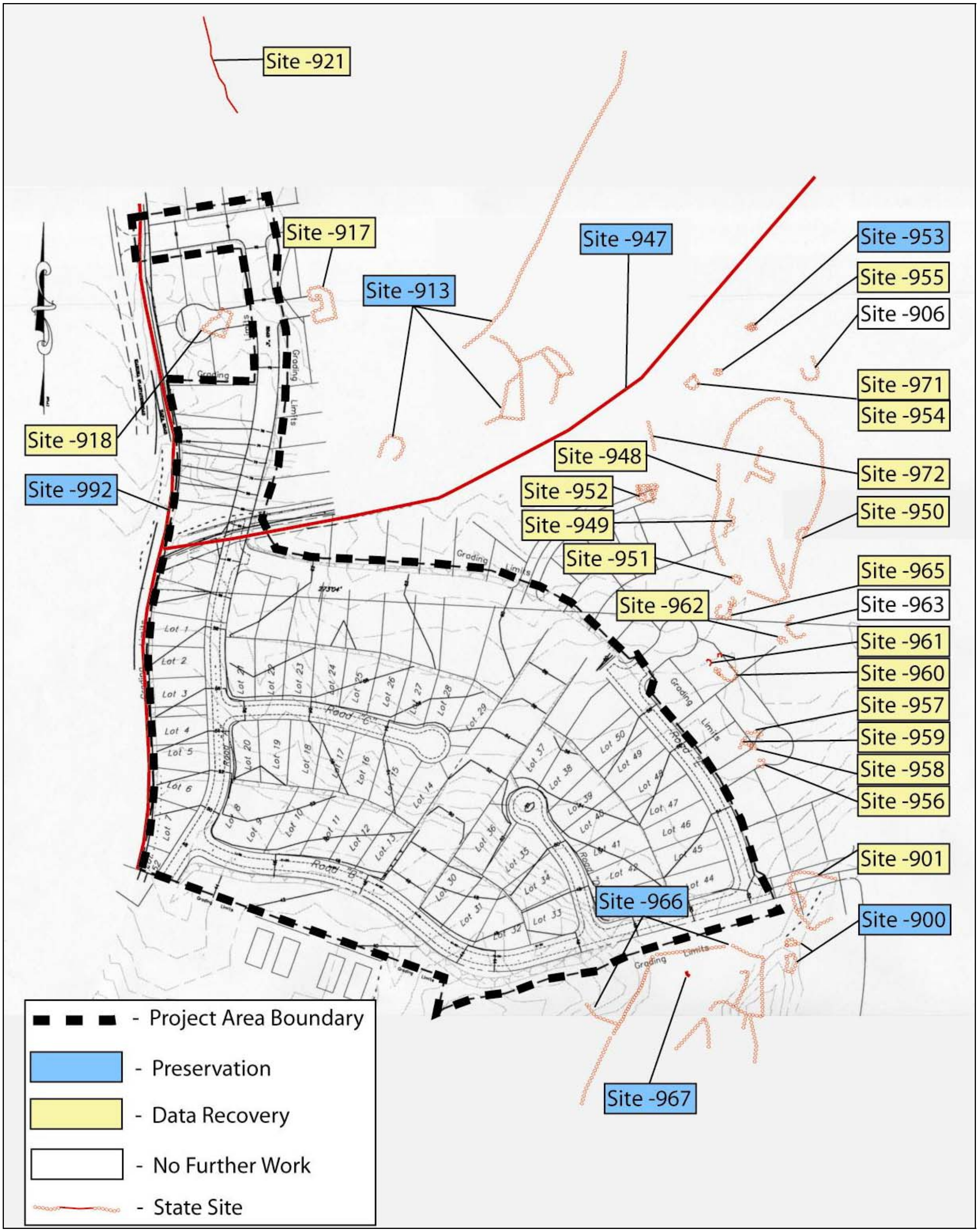

Figure 5. Map showing locations and recommendations for state sites in vicinity of project area

V. PROVISIONS OF THE INTERIM PRESERVATION PLAN

This document has been prepared as an interim protection plan. Interim protection measures will include the following:

1. Demarcated Buffer Zones

During any future construction in the immediate area(s), the buffer will be marked with an orange colored plastic barricade fencing erected on posts with appropriate signage, which will be apparent to operators of heavy equipment in the vicinity. Figure 6 illustrates the recommended locations of protective fencing demarcations and archaeological sites in the vicinity. Figure 7 shows recommended locations of protective fencing demarcations and the approximate lengths of each.

At sites 917 and 918, the interim protection buffer should be demarcated in a circular pattern with an approximate diameter of 22 meters (72 feet) around the perimeter of each site. In order to protect site –992, Hapa Road and the corresponding rock wall, the barrier demarcation should be erected along the east side of the wall (the western boundary of the project area), stretching approximately 347 meters (1138 feet). Along a portion of the eastern boundary, the demarcation should follow the project area boundary in a continuous line, stretching approximately 427 meters (1401 feet) total, (256 meters NW to SE plus 171 meters ENE to WSW) protecting all sites to the northeast and southeast. The railroad berm, site –947, which passes through a portion of the project area should be protected by two parallel demarcations, each measuring approximately 52 meters (171 feet), stretching from Hapa Road to the proposed intersection with the Phase I access road, and two shorter parallel demarcations, each measuring approximately 18 meters (59 feet), where the berm exits the perimeter of the project area on the east. These measures will remain in effect during all construction and landscaping activities in the vicinity. Avoidance instructions will be written into construction plans and specifications. At no time shall any construction work take place within the buffer zone.

2. Written Notification and Invitation to Verification of Buffer Establishment

The SHPD will be notified in writing once the interim buffer marker is erected and invited to verify the placement prior to any further land alteration near the sites.

3. On-site Briefing of all Trades Working in the Vicinity

All construction and landscaping crews working in the vicinity will have an on-site briefing informing them of the presence of the boundaries around the sites, asking for their avoidance of this area, and holding them accountable, for any breach of the maintenance of the integrity of the buffer zones. CSH will provide a form for all appropriate parties to sign indicating that they have been briefed on all protection measures.

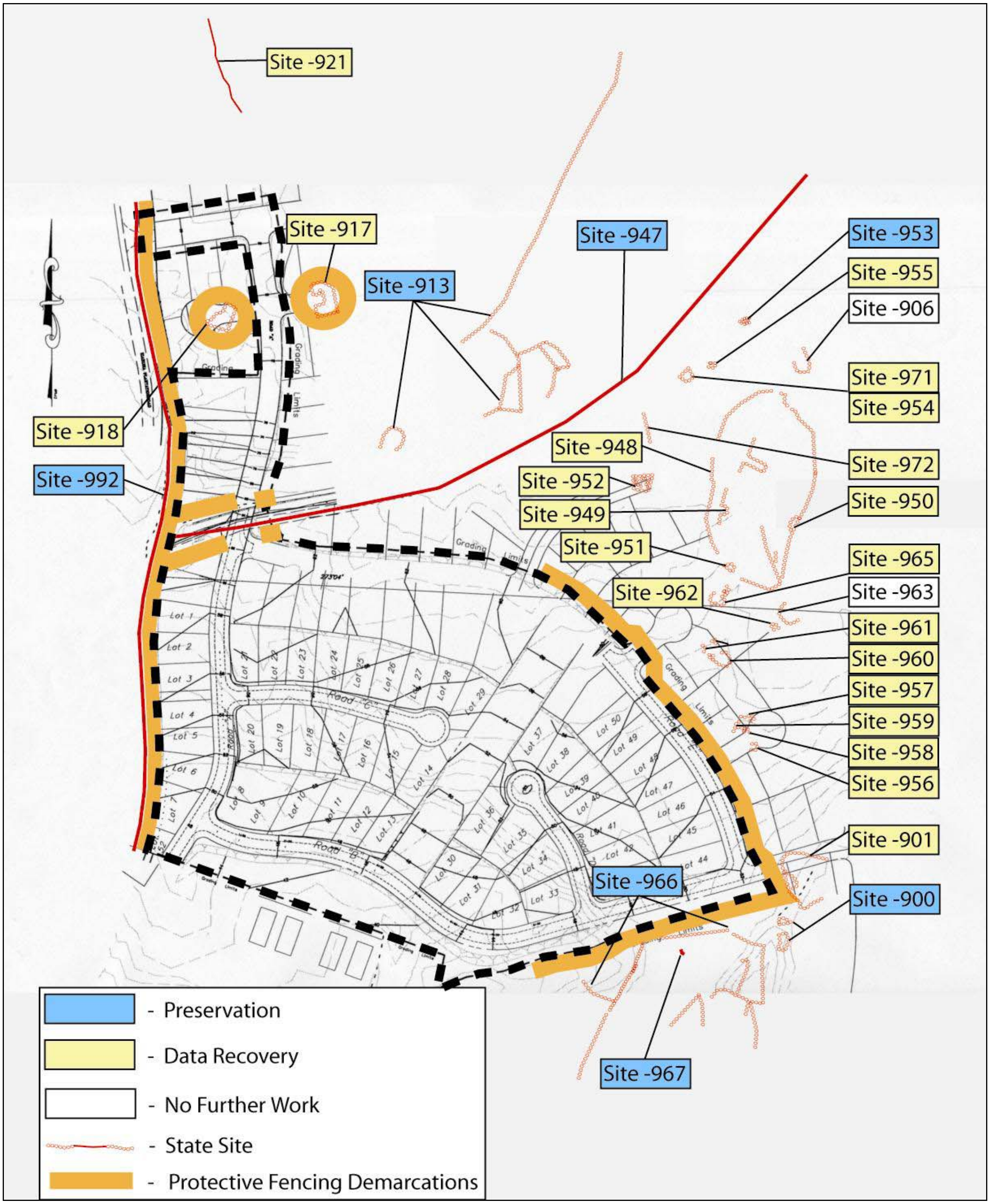

Figure 6. Map showing location of archaeological sites and recommended locations of protective fencing demarcations

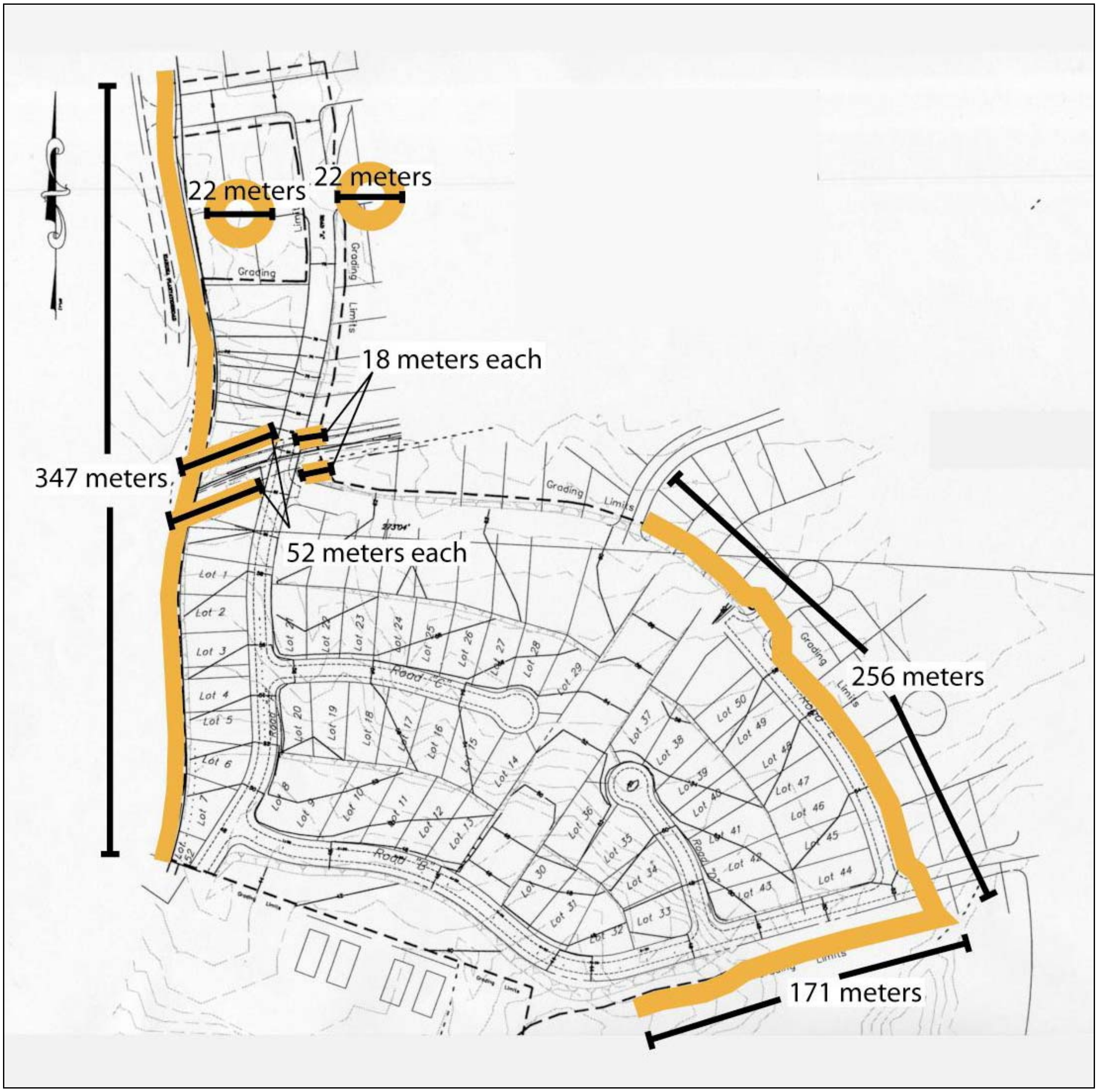

Figure 7. Map showing recommended locations and approximate lengths of protective fencing demarcations

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Appendix K

Cultural Impact Assessment
for an Approximately 203-Acre Parcel in
Kōloa Ahupua‘a, Kona District, Island of Kaua‘i
TMK (4) 2-18-013:001; 2-8-014:001, 002, 003, 004, and 019

by

Aulii Mitchell, B.A.,

Rodney Chiogioji, B.A.,

and

Hallett H. Hammatt, Ph.D.

for

Eric A. Knudsen Trust

Cultural Surveys Hawai‘i

(Job Code: KOLO 35)

June 2005

MANAGEMENT SUMMARY

Title	Cultural Impact Assessment for an approximately 203-acre parcel of Eric A. Knudsen Trust Lands, Kōloa Ahupuaʻa, Kona District, Kauaʻi (TMK (4) 2-18-013:001; 2-8-014:001, 002, 003, 004, and 019)
Date	June 2005
Project Number	Cultural Surveys Hawaiʻi Inc. (CSH) Job Code: KOLO 35
Agencies	State of Hawaiʻi Department of Health / Office of Environmental Quality Control (DOH / OEQC)
Project Land Jurisdiction	Private, Eric A. Knudsen Trust
Project Description	Eric A. Knudsen Trust proposes to develop the parcel as a residential community. Minimally, this would include grading, dwelling construction, and street and utility installation.
Project Acreage	Approximately 203 acres
Area of Potential Effect (APE)	For this cultural impact assessment, the project's APE is defined as the entire approximately 203-acre footprint of the proposed subdivision development. The assessment area and the project APE are one and the same.
Document Purpose	The project requires compliance with the State of Hawaiʻi environmental review process [Hawaiʻi Revised Statutes (HRS) Chapter 343], which requires consideration of a proposed project's effect on traditional cultural practices. At the request of the Eric A. Knudsen Trust, CSH undertook this cultural impact assessment to provide information pertinent to the assessment of the proposed project's impacts to cultural practices. The document is intended to support the project's environmental review by cultural consultation efforts [per the OEQC's *Guidelines for Assessing Cultural Impacts*]. The report may also serve to support the project's historic preservation review under HRS Chapter 6E-42 and Hawaiʻi Administrative Rules Chapter 13-284.
Consultation Effort	Hawaiian organizations, agencies and community members were contacted in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the project area and the vicinity. The organizations consulted included the State Historic Preservation Division (SHPD), the Office of Hawaiian Affairs (OHA), the Kauaʻi/Niʻihau Islands Burial Council, the Kauaʻi Historic Preservation Review Commission, and Hui Malama I Nā Kūpuna O Hawaiʻi Nei. Cultural anthropologist Aulii Mitchell conducted the consultation effort under the general supervision of Hallett H. Hammatt, Ph.D. (principal investigator).
Identified Cultural Issues	Historic properties – including archaeological sites – related to traditional Hawaiian culture within the project area. Possible burials within the project area. Ongoing cultural practices – including gathering of native plants – within the project area.

Cultural Impact Recommendations	In case of inadvertent discovery of burials during future development, adherence to procedures mandated by state law (Chapter 6E, Hawai‘i Revised Statutes), including coordination with appropriate state and county agencies. Implementation of preservation measures for historic properties already indicated in previous archaeological investigations of the project area. Incorporation of native Hawaiian plants in the landscaping of archaeological preserve area(s) with access to these areas for gathering purposes to be coordinated with local community members.

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I. INTRODUCTION

A. Project Description

At the request of the Eric A. Knudsen Trust (the owner of the parcel), Cultural Surveys Hawai‘i (CSH) conducted a Cultural Impact Assessment (CIA) of an approximately 203-acre project area is located in Kōloa Ahupua‘a, District of Kona, Island of Kaua‘i (TMK (4) 2-18-013:001; 2-8-014:001, 002, 003, 004, and 019) (Figure 1 & 2).

The Eric A. Knudsen Trust proposes to develop the project area as a residential community. Minimally, this would include grading, dwelling construction, and street and utility installation.

The project requires compliance with the State of Hawai‘i environmental review process [Hawai‘i Revised Statutes (HRS) Chapter 343], which requires consideration of a proposed project’s effect on traditional cultural practices. At the request of the Eric A. Knudsen Trust, CSH undertook this cultural impact assessment to provide information pertinent to the assessment of the proposed project’s impacts to cultural practices. The document is intended to support the project’s environmental review by cultural consultation efforts [per the OEQC’s *Guidelines for Assessing Cultural Impacts*]. The report may also serve to support the project’s historic preservation review under HRS Chapter 6E-42 and Hawai‘i Administrative Rules Chapter 13-284.

B. Scope of Work

The scope of work included:

1) Examination of historical documents, Land Commission Awards (LCAs), and historic maps, with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal, and other resources or agricultural pursuits as may be indicated in the historic record.

2) A review of the existing archaeological information pertaining to the general region as it may allow us to reconstruct traditional land use activities and identify and describe the cultural resources, practices, and beliefs associated with the area prior to construction.

3) Persons knowledgeable about the historic and traditional practices in the project area and region were contacted by letter and telephone. Interviews were conducted with persons knowledgeable about the historic and traditional practices in the project area.

4) A report was prepared to include the above items 1-3 and summarize the information gathered related to traditional practices and land use. The report also assessed the impact of the proposed action on the cultural practices and any features identified.

C. Work Accomplished

Historical documents, maps, and photographs were researched at: the Kaua‘i Historical Society; the Hawai‘i State Archives; the Survey Office of the Department of Accounting and

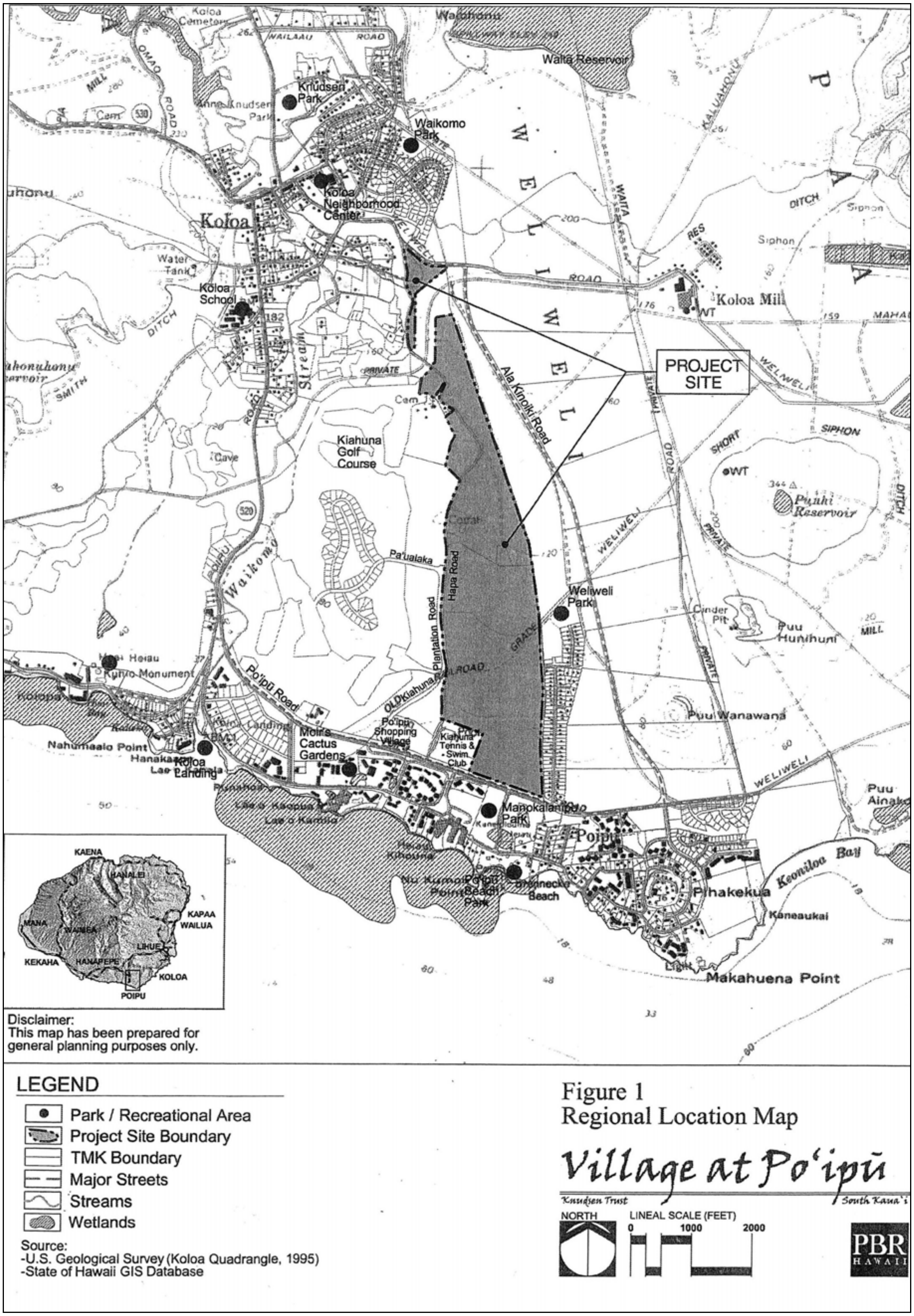

Figure 1. Portion of 7.5-minute U.S. Geological Survey map, Kōloa Quad (2000), showing project area in dotted outline.

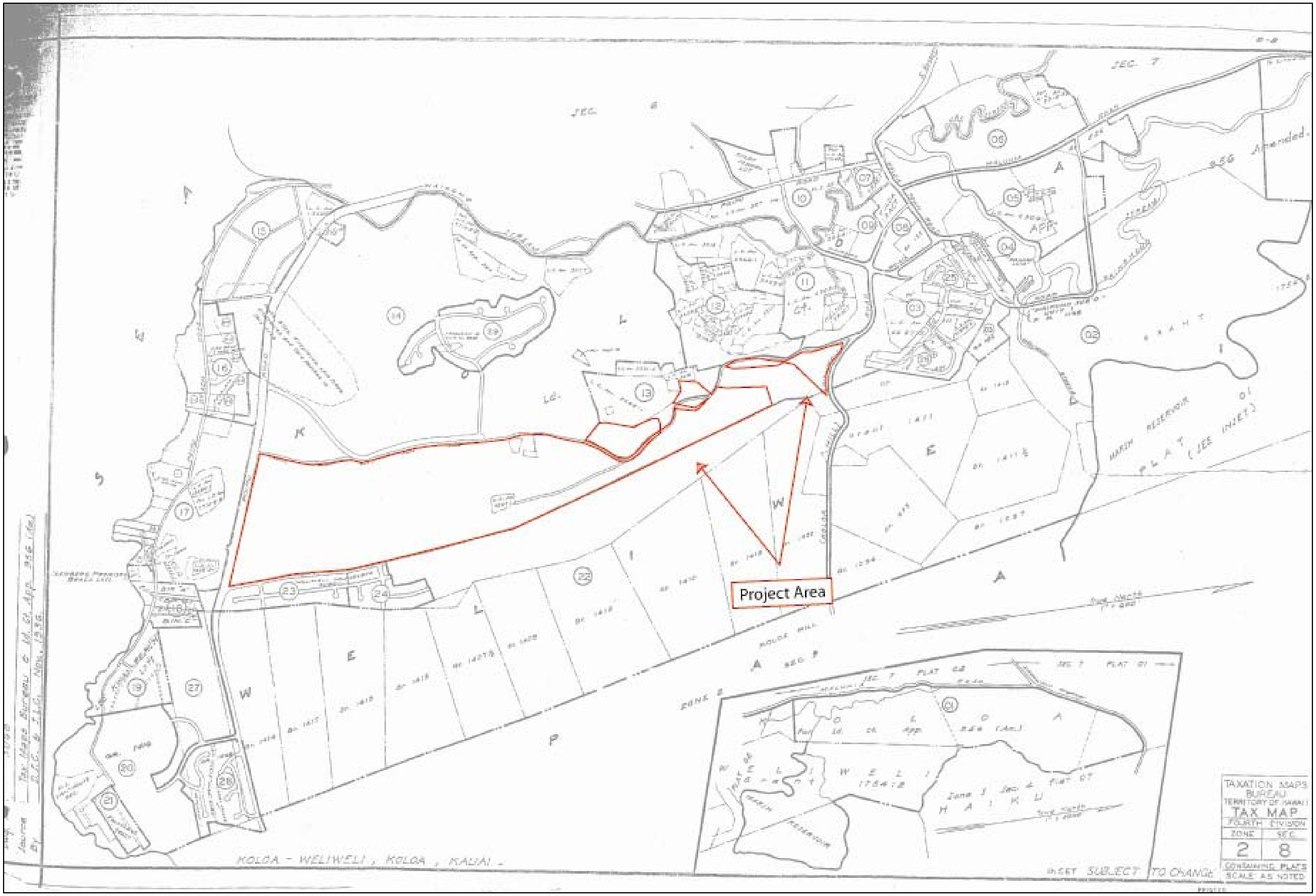

Figure 2. TMK 2-8-14 showing project area

General Services; the Hawai‘i State Library; the Bernice Pauahi Bishop Museum archives and library; Hamilton Library at the University of Hawai‘i Mānoa; the Mission Houses Museum Library; the State Historic Preservation Division (SHPD) library; and the library of CSH.

Hawaiian organizations, government agencies, community members, and cultural and lineal descendants with ties to Kōloa were contacted to: (1) identify potentially knowledgeable individuals with cultural expertise and knowledge of the project area and the surrounding vicinity, and (2) identify cultural concerns and potential impacts within the project area. Results of the community contact process and community interviews are presented in Sections VII and VIII below.

Cultural anthropologist Aulii Mitchell conducted the consultation effort under the general supervision of Hallett H. Hammatt, Ph.D. (principal investigator).

II. TRADITIONAL AND LEGENDARY ASSOCIATIONS OF KŌLOA AHUPUA‘A

Kōloa was a particularly important *ahupua‘a* in traditional Hawaiian times. The documentation of at least fourteen *heiau* (temples) of varying sizes and functions in the Kōloa area (Thrum 1907, Bennett 1931) and the association of legendary-historic figures such as Kawelo and Aikanaka with the *heiau* suggest a heightened cultural richness of the *ahupua‘a*.

Further confirmation of a rich traditional life within Kōloa is the presence of a *hōlua* (sled) course on the slopes of Pu‘u o Hewa in the *mauka* (upland) reaches of the *ahupua‘a* and by the myriad legends attached to Maulili Pool, a sacred place once located in the present Kōloa Town. J. K. Farley (1907:93) describes the pool and its legendary associations:

> The pool of Maulili, on Waikomo stream...is a few hundred feet south of the Maulili road bridge. The gods Kāne, and his brother, Kanaloa, are said to have once slept above it, on its eastern bank and left the impress of their forms as can be seen in the apapa...The apapa in this vicinity is called an “Unu” and a “Heiau”, but was never walled in, it is said. [This heiau may be the Maulili Heiau described by Makea above.] On the nights of Kāne the drums are heard to beat there, also at the sacred rocks, or unu's, of Opuokahaku and Kānemilohae, near the beach of Po‘ipū...
>
> In the Maulili pool lived a large Mo‘o, named “Kihawahine”...The eastern wall of the pool, just below the resting places of Kāne and Kanaloa, for a short distance, only, is called the “Pali of Kōloa.” The District of Kōloa is named for this Pali, we are told by old Hawaiians. To the south of the Pali o Kōloa, in the wall is a rock named ‘Waihanau'...as one of their meles has it:
>
> *Aloha wale ka Pali o Kōloa,*
>
> *Ke Ala huli i Waihānau e, hānau.*
>
> To the south of Waihānau is a projecting rock named “Ke elelo o ka Hawai‘i” -- the tongue of Hawai‘i, said to have been wrested and brought from Hawai‘i by the Kaua‘i warrior Kawelo, of Wailua.
>
> At the southern end of the Maulili pool started two large ‘auwai's, that watered the land east and west of Kōloa.

Thus, this sacred legend-imbued locus was the source that gave life to the lowland taro patches of Kōloa. These special associations would not have been lost on the Hawaiians of Kōloa who were dependent upon those waters.

III. CULTURAL AND HISTORICAL BACKGROUND

A. Historical Setting: Pre-Contact Kōloa

The project area is in the *ahupuaʻa* of Kōloa in the Kona District of the island of Kauaʻi. Few records exist that document traditional Hawaiian life in Kōloa Ahupuaʻa. While settlement by westerners with religious and commercial interests make the area a focus of documentation after the first quarter of the nineteenth century, the accounts generated generally focus on the lives and concerns of the westerners themselves, with only anecdotal references to the Hawaiian population. Two nineteenth century documents (Boundary Commission Testimony of 1874 and a Lahainaluna manuscript of 1885), however, did provide two Hawaiians an opportunity to speak for themselves and thus offer a possible insight into the life of Kōloa before the arrival of westerners.

A dispute over the northern boundary of Kōloa Ahupuaʻa in 1874 led to a hearing before Duncan McBryde, the Commissioner of Boundaries for Kauaʻi. One native witness, Nao (who describes himself as born in Kōloa but presently living in Haʻikū), in order to show that Hoaea (the area in dispute) was indeed at the northern boundary of Kōloa, testifies: "At Hoaea tea [sic] leaves were hung up to show that there were battles going on" (Boundary Commission Kauaʻi, Vol. 1 1874:124). That there was a traditional "warning system" --well-known to all natives-- suggests that Kōloa, throughout its history, may well have been the scene of some serious conflicts, serious enough and perhaps often enough to warrant devising such a system.

Additional evidence of a rich history within Kōloa is offered in a Lahainaluna document produced eleven years later. This document appears to be based on an oral historical project. On September 7, 1885, a student from Lahainaluna Schools (HMS 43 #17) interviewed Makea – "a native who is well acquainted with Kōloa" -- and recorded "what she said about the well-known places in the olden times." More than sixty-four years after the abolition of the *kapu* system and almost as many years of contact with westerners, Makea was able to describe in detail fourteen *heiau* within the Kōloa area. For example:

> Maulili was the first heiau of south Kōloa. Kapulauki was the first chief of Kōloa, Kiha came next. That is the chief I know of. He was a ruling chief of Kauaʻi in the olden days, when the heiau was standing there. It had already been built and men had been sacrificed on its altars. This Kiha was called Kiha-of-the-luxuriant-hair. Another name for him was Kakae and another was Ka-pueo-maka-walu (Right-eyed-owl).
>
> This heiau was also famous for this reason -- it was the first heiau to which Kawelo was carried after he had swooned in Wahiawa, in the battle where stones were used as missiles.
>
> The location of this heiau was not known, but a deaf mute knew and it was he who pointed it out to the chiefs, and that is how it was rediscovered in the olden days.
>
> Kiha lived on the eastern side of the heiau and Aikanaka lived on the northeastern side. This chief, Aikanaka, was the one with whom Kawelo fought and he was the owner of this heiau at that time.

Bernice Judd, writing in 1935, summarizes most of what was known -- into the first decades of this century -- of the traditional Hawaiian life of Kōloa before western contact:

> In the old days two large ‘auwai or ditches left the southern end of the Maulili pool to supply the taro patches to the east and west. On the kuaunas or embankments the natives grew bananas and sugar cane for convenience in irrigating. Along the coast they had fish ponds and salt pans, ruins of which are still to be seen. Their dry land farming was done on the kula, where they raised sweet potatoes, of which both the tubers and the leaves were good to eat. The Hawaiians planted pia [arrowroot] as well as wauke [mulberry] in patches in the hills wherever they would grow naturally with but little cultivation. In the uplands they also gathered the leaves of the hala [screwpine] for mats and the nuts of the kukui for light. (Judd 1935:53)

It appears that the relatively good situation for the development of irrigated agriculture focused farming and habitation at elevations including the present project area (see Section IV: “The Kōloa Field System” below).

B. Early Historic Period

Accounts by visitors and settlers at Kōloa Ahupua‘a focus on these westerners’ own concerns--religious and commercial--as these concerns appropriate the historical record of Kōloa in the 1800s. However, scattered throughout the accounts are occasional references to the Hawaiians of the *ahupua‘a*, which may give some insights into their lives.

The American Board of Commissioners for Foreign Missions (ABCFM) missionary Samuel Whitney described, in an article in the *Missionary Herald* (June 1827:12), a visit to Kōloa with Kaikio‘ewa, the governor of Kaua‘i, in 1826:

> The people of this place were collected in front of the house where the old chief lodged in order to hear his instructions. After a ceremony of shaking hands with men, women, and children they retired...
>
> Our company consisted of more than a hundred persons of all ranks. The wife of the chief, with her train of female attendants, went before. The governor, seated on a large white mule with a Spaniard to lead him, and myself by his side, followed next. A large company of aipupu, *[‘ā‘īpu‘upu‘u*] cooks, attendants came on in the rear.

Whitney's account suggests something of the deference paid to the *ali‘i* (royalty) by the local populations and the scale at which the *ali‘i* carried out their functions. An even grander view of that deference is provided in an account of a later visit by an *ali‘i* to Kōloa. John Townsend, a naturalist staying in Kōloa in 1834, described a visit by Kamehameha III (in Palama and Stauder 1973:18):

> In the afternoon, the natives from all parts of the island began to flock to the king’s temporary residence. The petty chiefs, and head men of the villages, were mounted upon all sorts of horses from the high-headed and high-mettled California steed, to the shaggy and diminutive poney [sic] raised on their natives hills; men, women, and children were running on foot, laden with pigs, calabashes of Poe [sic], and
>
> every production of the soil; and though last certainly not least, in the evening there came the troops of the island, with fife and drum, and “tinkling cymbal” to form a body guard for his majesty, the king. Little houses were put up all around the vicinity, and thatched in an incredibly short space of time, and when Mr. Nuttall, and myself visited the royal mansion, after nightfall, we found the whole

> neighborhood metamorphosed; a beautiful little village had sprung up as by magic,and the retired studio of the naturalists had been transformed into a royal banquet hall.

On December 31, 1834, Peter Gulick and his family arrived in Kōloa. Apparently the first foreigners to settle in the *ahupuaʻa*, they initiated the process of rapid change that would re-shape the life of Kōloa in the nineteenth century. In 1835, a 30 by 60 ft. grass house was erected as a meeting house and school (probably located at Kōloa Town). Mr. Gulick initiated sugar cane cultivation and collected a cattle herd for the Protestant Mission. In 1837, a 45 by 90 ft. adobe church was built (probably at the same ABCFM site) and the first mission doctor, Thomas Lafon, arrived to assist Mr. Gulick (Damon 1931:179,187). The Kōloa mission station apparently flourished immediately. Charles Wilkes (1845:64), a member of the U.S. Exploring Expedition visiting Kōloa in 1840, recorded:

> The population in 1840, was one thousand three hundred and forty-eight. There is a church with one hundred and twenty-six members, but no schools. The teachers set apart for this service were employed by the chiefs, who frequently make use of them to keep their accounts, gather in their taxes &c [and for similar tasks]. The population is here again increasing partly by immigration, whence it was difficult to ascertain its ratio.

Other sources, however, give different population figures for Kōloa during the first half of the nineteenth century. In 1834, according to a report by missionaries on Kauaʻi, the inhabitants of the *ahupuaʻa* numbered 2,166. An article in the *Pacific Commercial Advertiser* of December 21, 1867 estimated that the population in 1838 was about 3,000 (though, by 1867, it had been reduced to a third of that number). James Jackson Jarves (1844:100), who visited Kōloa and Kauaʻi for nine months during the early 1840s, recorded:

> Kōloa is now a flourishing village. A number of neat cottages, prettily situated amid shrubbery have sprung up, within two years past. The population of the place, also, has been constantly increasing, by emigration from other parts of the island. It numbers, now, about two thousand people, including many foreigners, among whom are stationed a missionary preacher, and physician, with their families.

The arrival of “many foreigners” was the cause of, and the native immigration to Kōloa was the result of, the many commercial activities that burgeoned beginning in the 1830s. In 1835, Ladd and Company gained from the king and local chiefs the lease of about one thousand acres at Kōloa for 50 years at $300 a year and “allowed the use of the waterfall and an adjoining mill site at Maulili pool, not far from the thousand acres, together with the right to build roads, the privilege of unrestricted buying and selling and freedom from local harbor dues” (Judd 1935:57). Ladd and Company was not the first to mill sugar cane in the area as there was a Chinese-operated granite roller mill in operation at Māhāʻulepū, Kōloa, in 1830. It was, however, the first plantation-organized industry in Hawaiʻi (Damon 1931:176,198). Judd (1935:57) notes the following:

> The company was permitted to hire natives to work on the plantation provided they paid Kauikeaouli, the king, and Kaikioʻewa, the governor of Kauaʻi, a tax for each man employed and paid the men satisfactory wages. The workers were to be exempt from all taxation except the tax paid by their employers.

Judd further described the revolutionary implication of this arrangement: “The significance of Ladd & Co.’s lease lay in the fact that it was the first public admission by the Hawaiian chiefs that their subjects had rights of personal property backed with a guaranty of protection to that property” (Judd 1935:58). Local chiefs, fearful of usurpation of their power, resisted the company's first efforts to recruit workers, forcing the king’s intervention.

The commercial activity initiated by the Ladd and Company plantation had widespread ramifications. Kōloa Town and the landing at the mouth of Waikomo Stream became major commercial centers. The landing – or “roadstead” as it was called – was a busy port during the mid-1800s. “An estimate in 1857 stated that 10,000 barrels of sweet potatoes were grown each year at Kōloa, and that the crop furnished nearly all the potatoes sent to California from Hawai`i. Sugar and molasses were also chief articles of export” (Judd 1935: 326). Whalers also used the Kōloa roadstead during this period (1830-1870) and took on provisions of squashes, salt, salt beef, pigs, and cattle. Hawaiians grew the squashes (pumpkins) on the rocky lands north of the landing, and numerous salt pans were located along the shore near the landing.

Ladd and Company ceased operating in 1845. Then, following a succession of individual and partnered ownerships, a new enterprise, Kōloa Sugar Company, was established in 1880. In 1948, the Kōloa Sugar Company became part of Grove Farm Company.

C. Mid-Nineteenth Century: The Mahele and Land Commission Awards

Toward the mid-nineteenth century, the Organic Acts of 1845 and 1846 initiated the process of the Mahele – the division of Hawaiian lands – which introduced private property into Hawaiian society. In 1848, the crown, the Hawaiian government, and the *ali‘i* received their land titles. Subsequently in the Mahele, Land Commission Awards (LCAs) for *kuleana* parcels were awarded to commoners and others who could prove residency on and use of the parcels they claimed.

The bulk of Kōloa Ahupua‘a was awarded to Moses Kekuaiwa in LCA 7714-B. Kekuaiwa was born July 20, 1829, the son of Kekuanaoa and Kinau, and the brother of Alexander Liholiho (Kamehameha IV), Lot Kapuaiwa (Kamehameha V), and Victoria Kamāmalu. He died November 24, 1848.

The Kōloa award to Kekuaiwa encompassed approximately 8,620 acres of “West Kōloa”, referring to the *ahupua‘a* itself, not the larger district of the same name. The next largest award in the *ahupua‘a* went to the Protestant Mission (ABCFM) and consisted of approximately 825 acres (LCA 387). The majority of the mission lands were located in the vicinity of Kōloa Town, where the parsonage was located. Large parcels just *mauka* of Kōloa Town were utilized for sugarcane cultivation and cattle pasture.

Eighty-eight other *kuleana* awards were given to individuals within Kōloa Ahupua‘a. The majority of these LCAs were located in or around Kōloa Town itself. This concentration of awards around the town area may reflect both the traditional land settlement pattern, a focus on the resources of Maulili Pool and Waikomo Stream (a permanent stream), and a more recent movement of the populace to the plantation and missionary centers.

Three LCAs are located within the present project area. These three and other adjacent awards are discussed in Section E (“Historic and Modern Documentation of the Present Project Area”) below.

D. Later 1800s to Present

The cane growing activity of Ladd and Company would inevitably affect the lives of the inhabitants of the rest of the *ahupua‘a*. Traditional settlement patterns (e.g. permanent and temporary habitation interspersed throughout the irrigated agricultural fields near the coastal zone and traditional farming along streams) would have been distorted by a shift to settlement in Kōloa Town where sugar cane milling activities were located, and a shift to cash crops rather than taro.

The early success of Ladd and Company (before its bankruptcy in 1845) was an impetus for other entrepreneurial attempts within Kōloa. Silkworm farming, oil extraction from *kukui* nuts, cigar manufacturing, sago raising, and tapioca manufacturing were all attempted with varied success during the middle third of the nineteenth century.

Another major area of commercial enterprise was associated with the whaling industry at Kōloa Landing. Accounts of visitors suggest that the inhabitants of Kōloa took advantage of their nearness to the landing to participate in the booming trade of the port. An article in the *Pacific Commercial Advertiser* of Feb. 19, 1857 described the salient characteristics of the port at mid-century and mentions:

> From the landing there is a good carriage road to the town, distant about two miles. Large quantities of firewood, bullocks and sweet potatoes are furnished to whalers in this port, and these chattels can nowhere be procured cheaper or better. It is estimated that 10,000 barrels of sweet potatoes are cultivated annually here, which are thought to be the best on the islands. Nearly all the potatoes furnished for the California market are produced here...Sweet potatoes, sugar and molasses constitute the chief trade of the port.

Kōloa became the official port of entry for Kauaʻi in the 1850s and participated in the profitable trade with the whaling industry whose peak years ran from the 1830s to the 1860s. It seems likely the demand for firewood, bullocks, sweet potatoes, sugar and molasses at Kōloa Landing was met to at least some small degree by activities in the *mauka* regions of Kōloa.

During the later decades of the nineteenth century the Knudsen family would enter into the Kōloa historical record. As Donald Donahugh (2001:191) notes:

> Valdemar Knudsen came to Kauaʻi from Norway by way of California in 1852, built a home in Kekaha, which he named ʻWaiʻawa' (bitter water), and started a cattle ranch there. In 1865 he married Anne Sinclair, daughter of Eliza Sinclair, who owned the island of Niʻihau and the *ahupuaʻa* of Makaweli (fearful features). Eliza bought most of the Kōloa *ahupuaʻa* in 1870 and gave it to Anne that year as a dowry. When Valdemar died, Anne set up a trust and through it leased her land first to Kōloa Plantation, then to Grove Farm, and finally to McBryde. Anne died in 1920, and Knudsen descendants formed trusts in their own names. First Hawaiian
>
> Bank manages the activities of all of them. Rather than speaking of several trusts, it is customary to use the generic term Knudsen Trust, as we will here.

The present project area is a portion of the Eric A. Knudsen Trust.

Sugarcane cultivation in Kōloa expanded in the 1890s with the forming of McBryde Sugar Company. Benjamin F. Dillingham incorporated "three estates, namely Kōloa Agricultural Co. (no connection with Kōloa Sugar Co.), ʻEleʻele Plantation, and Wahiawa Ranch" (Conde and Best 1973:191). Theo H. Davies was the acting agent until 1901 when Alexander and Baldwin took over agency control.

Expansion of cane fields and plantation rail lines was rapid. By 1903, McBryde had completed rail lines to its Kōloa fields and Kōloa Landing. The manager's report of 1904 notes: "Our permanent railroad had been graded into Kōloa Village...A span has also been run down from the main track to the coral sand beach between Kukuiula and Kōloa landing, so that we are able to load sand as required from fertilizer and other uses...” (Conde and Best 1973:191).

Kōloa Landing was phased out around 1925 when McBryde Sugar Company and Kōloa Sugar Company began using Port Allen. Soon after, McBryde ceased to use several of the Kōloa fields.

E. Historic and Modern Documentation of the Present Project Area

Records of the mid-nineteenth century Mahele provide the first specific documentation of traditional Hawaiian activities, practices and land use within the project area. As noted above, three LCAs were granted for *ʻāpana* (parcels) within the project area. The locations of the three awards are shown on a portion of an 1891 map of Kōloa (Figure 3). Also indicated on the map are the locations of five awards adjacent to the project area. Information on the awards from Mahele documents is presented in Tables 1 and 2 below.

The Mahele documents indicate that, within and around the present project area, land usage and activity by the mid-nineteenth century included habitation and taro cultivation. This may reflect the continuation into that century of traditional Hawaiian land use within the project area.

Especially revealing about the present project area is testimony in LCA 2668 to R.A. Walsh of the Roman Catholic Mission. Rev. Walsh states:

> ...the spot where I now reside was given to me by Kahelemakule, the inspector of schools, by order he said of Kekauonohi [Governess of Kauaʻi Island].
>
> A part of the land was at that time occupied by a native named Kanehekili, and Kahelemakule said I might have his land in case Kanehekili agreed to it; who on my speaking to him, willingly resigned his part of the land gave me up all the title he had to it. Since this I have been left in the undisturbed possession of it. I have paid from 1 to 3 dollars each year for the land since, though I did not consider it was his majesty’s intention to impose any tax on me for it.
>
> The spot of land is in East Koloa, east of all the taro lands except mine and one other taro plot. It is bounded west, north and east by a water run, and on the south by an almost barren stoney place. In addition to the land contained in these boundaries, Kahelemakule allowed me to take a small spot on the north side of it whereon to build a chapel and schoolhouse.

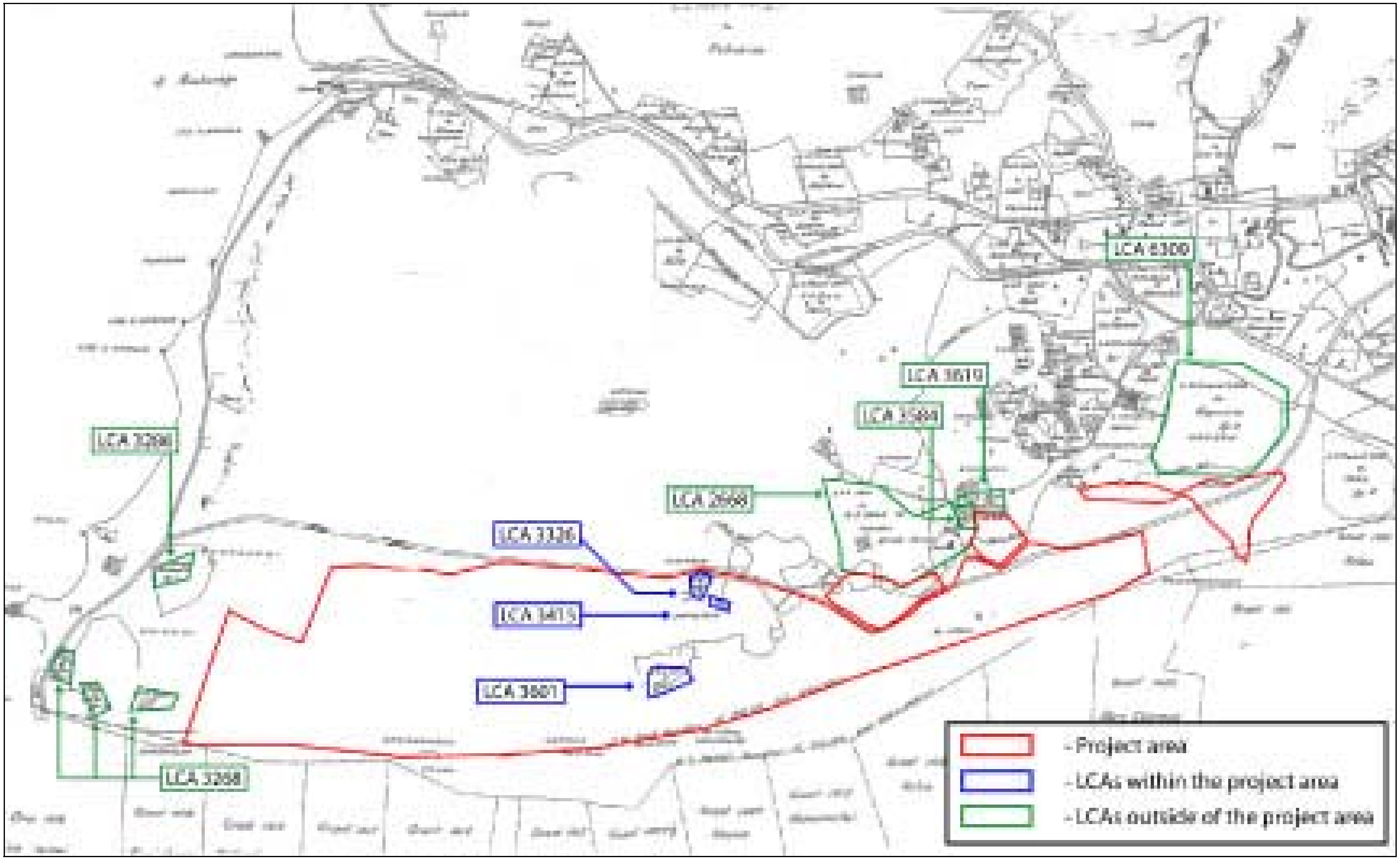

Figure 3. Portion of 1891 map of Kōloa by M.D. Monsarrat showing locations of Land Commission Awards within and adjacent to the project.

> The land contains about 3 acres and only produces taro, sweet potatoes and grass. It has very little soil over a stratum of lava, and in many parts none at all. (Foreign Register Vol. 3 1894:155-157)

Table 1. LCAs within the project area

LCA Number	Awardee	\`Ili	Land Use
3326	Wahapuu	Kikiaola	House lot, 1 *lo‘i*
3415	Isaraela Pehu	Kapalaalea	*Kula*, 3 *lo‘i*
3601	Kenoi	Kamaemae	*lo‘i*

Table 2. LCAs adjacent to the project area

LCA Number	Awardee	\`Ili	Land Use
2668	Roman Catholic Mission (Robert A. Walsh)	Koloa Hikina	*Kalo*, *kula*, *lo‘i*
3268	Lae	Waiohai	House lot, 9 *lo‘i*
3286	Walewale	Puokahaku	*lo‘i*
3584	Kaanaana	Keaku	*lo‘i*
3619	Kahukina	Keaku	*Kula*, 8 *lo‘i*

Rev. Walsh identifies his parcel as located “east of all the taro lands except mine and one other taro plot,” suggesting that this portion of Kōloa, which includes the present project area, comprises the eastern end of the *lo‘i* (irrigated terrace) system of the *ahupua‘a.* The *lo‘i* in this portion of Kōloa, again including those in the present project area, are likely fed by the “water run” that bounds the Catholic Mission parcel. Rev. Walsh records that the parcel “only produces taro, sweet potatoes and grass,” which may summarize the products of other *kuleana* parcels in the vicinity, including those in the project area. Similarly, the testimony to “very little soil over a stratum of lava, and in many parts none at all” may describe overall conditions across the landscape, including within the project area.

While only three LCA parcels are located within the present project area, the area may have been more densely filled with dryland and irrigated fields, and habitation sites in the centuries before the diminishing of the Hawaiian population in the 1800s. It is likely that the LCA parcels containing *lo'i* which are located just *makai* of the project area – LCAs 3268 and 3286 – were fed by the same *'auwai* (irrigation ditch) descending through the present project area that fed LCAs 3326, 3415 and 3601. Such *'auwai* would have watered many more *kuleana* than the three recorded in the mid-nineteenth century.

Further documentation of the project area during the second half of the nineteenth century is found on a map hand-drawn by a *kama'āina* Kōloa resident. Most likely in 1938, Judge Henry Kawahinehelelani Blake of Kōloa (1874-1948) drew a colored map of “Koloa Village” depicting what the area looked like in 1888 when he was a boy of fourteen (Figure 4). The map suggests that taro *lo'i* continued in existence in the 1880s. The population of Kōloa, based on the house sites, continued to be dispersed across the Kōloa plain.

The present project area appears in the lower left hand corner of the map, to the east and *makai* of the “Catholic Mission”. Judge Blake indicates taro *lo'i* and houses in the central portion of the project area. These *lo'i* and houses likely represent the continuation, into the last decades of the nineteenth century, of the fields and house lots identified in the LCA records.

By the first decades of the twentieth century, cane fields of the Kōloa Sugar Company and McBryde Sugar Company spanned the landscape of Kōloa. However, sugar company field maps from the early 1900s indicate only small incursions of sugarcane within the present project area.

A second map drawn by Henry Kawahinehelelani Blake shows “Kōloa Village” in 1938 (Figure 5). The map was likely drawn by Judge Blake in 1938 along with the map of the village in 1888 to record a “then and now” portrait of Kōloa. The map indicates “cane lands” and “pasture” in the vicinity of the project area. House sites are located *mauka* and *makai* of the project area. The taro *lo'i* that characterized the Kōloa landscape in the 1880s are no longer present.

A 1951 aerial photograph of Kōloa shows that, the by mid-twentieth century, the present project area comprised areas of open pasture, with sugar cane extending into small portions (Figure 6). No structures appear in the project area.

An aerial photograph taken on April 30, 2000 indicates that, at the end of the twentieth century, the project area continued to comprise open and brush-covered pasture land with now-discontinued sugar cane fields also present (Figure 7).

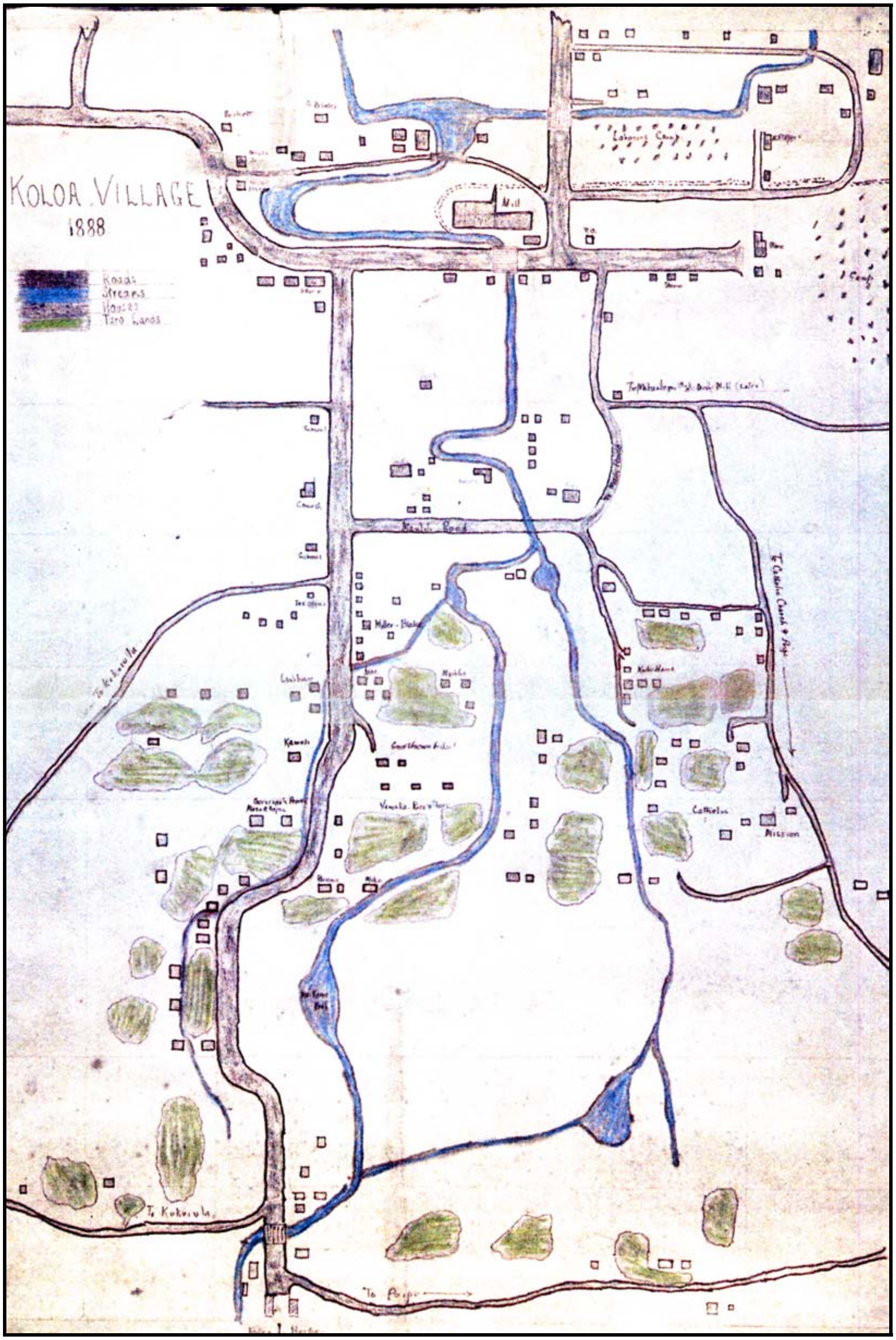

Figure 4. Hand-drawn map of Kōloa Village, 1888, by Judge Henry K. Blake (1874-1948) (Kaua'i Historical Society)

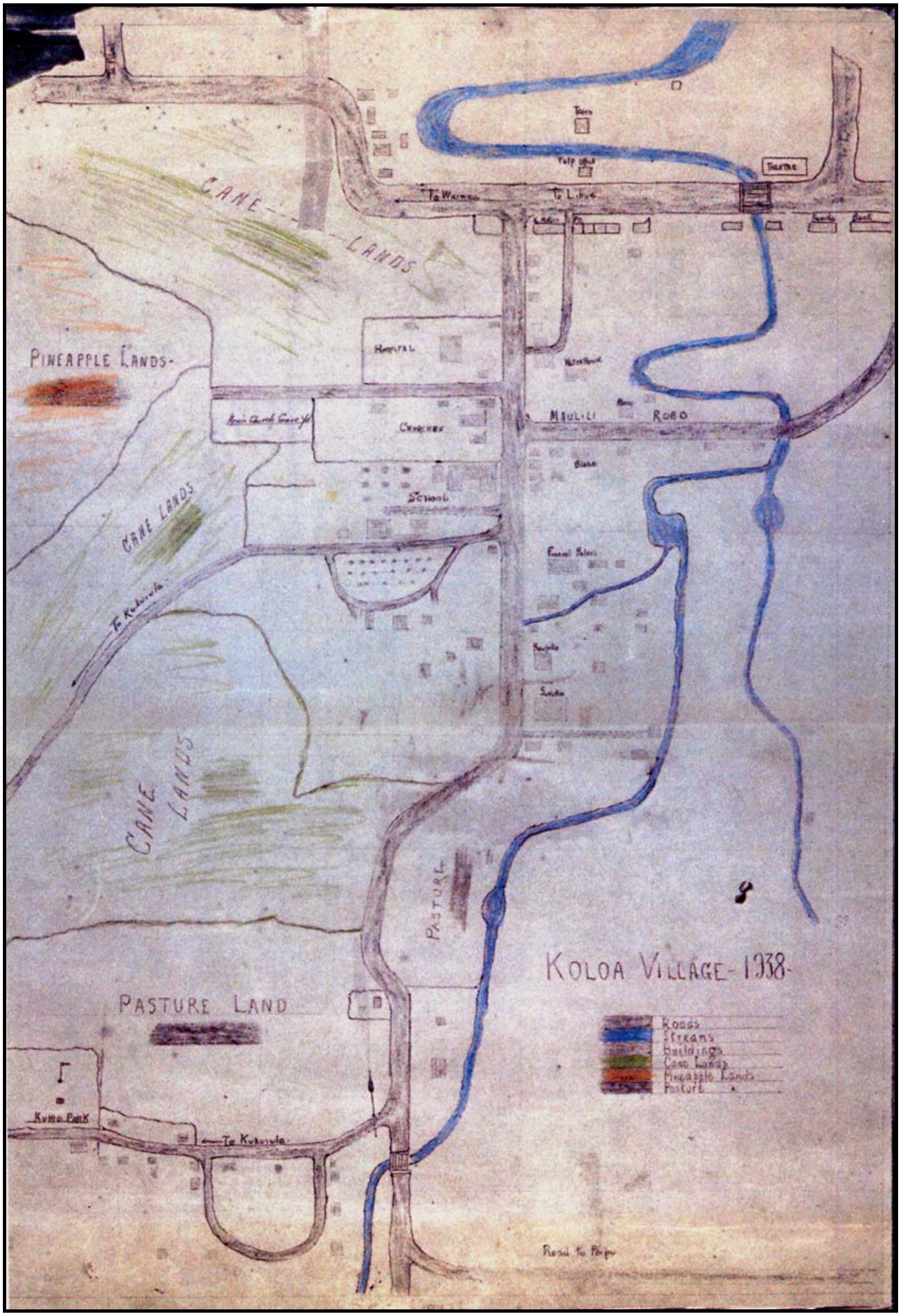

Figure 5. Hand-drawn map of Kōloa Village, 1938, by Judge Henry K. Blake (1874-1948) (Kaua‘i Historical Society)

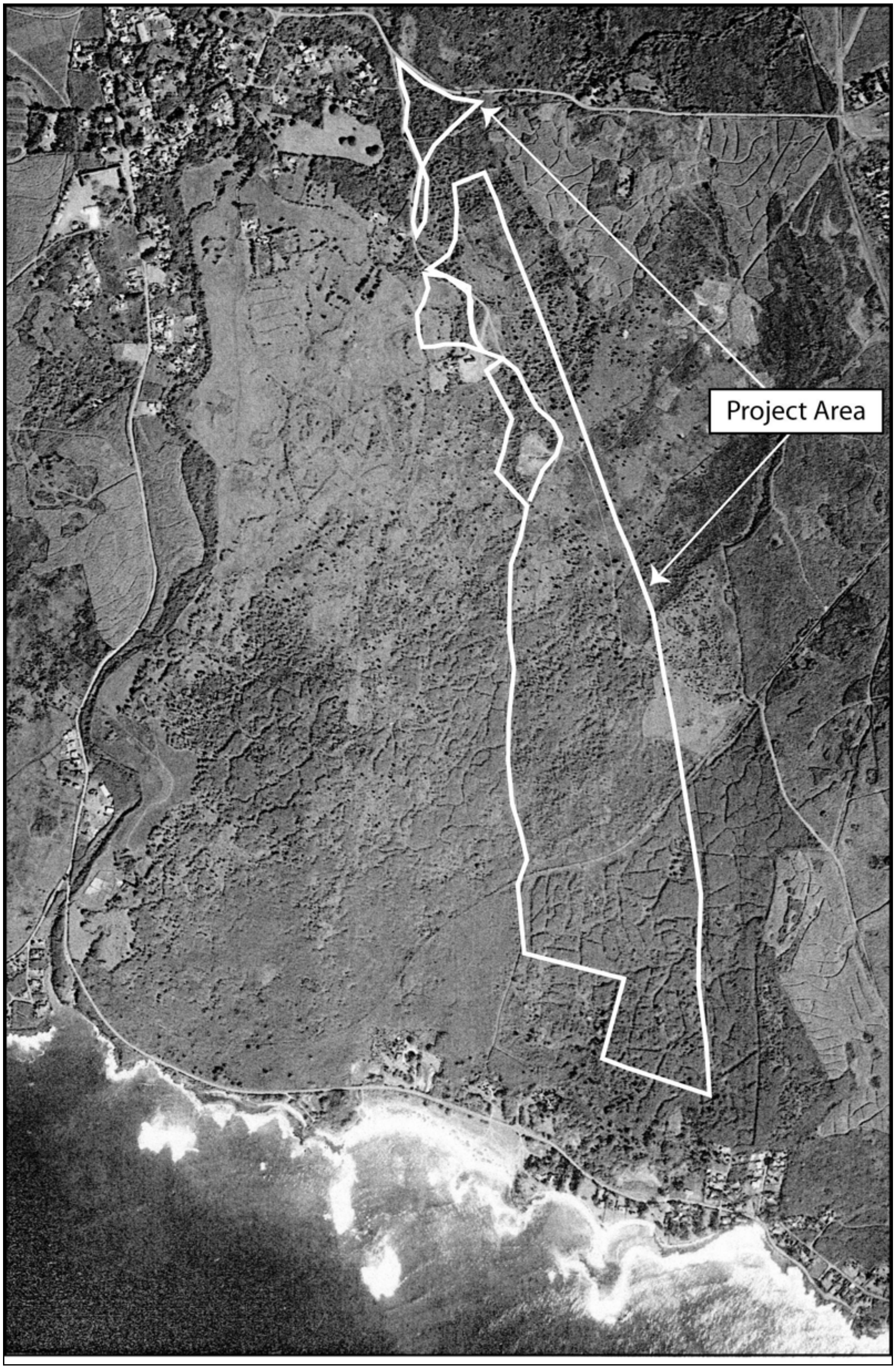

Figure 6. Aerial photograph of Kōloa (1951) with present project area indicated

Figure 7. Aerial photograph of Kōloa (April 30, 2000) with present project area indicated

IV. THE KŌLOA FIELD SYSTEM

The present project area is located at the eastern end of an expansive irrigation system that spread out across the *makai* plain of Kōloa Ahupuaʻa. The features of the present project area can only be comprehended in the larger context of the *ahupuaʻa* system.

A. The Kōloa Field System

Often, it has been assumed that the majestic, soil-rich valleys were the preferred environments for the development of irrigated agriculture in the Hawaiian Islands and that the modifications of broad lava plains and slopes for irrigation (e.g. Kōloa on Kauaʻi and Lalamilo on Hawaiʻi Island) came as later developments in response to a need to expand food production. Based on archaeological investigations – including detailed mapping, excavation of habitation and agricultural features, and development of a C14 chronology – over an extended period in the *makai* portions of Kōloa Ahupuaʻa, CSH has been able to define the "*loʻi* lands of Kōloa" as a system – a set of interrelated features harmoniously interacting to form a unified whole. This "Kōloa Field System" extended from Lāwaʻi to Weliweli, covering all of Kōloa Ahupuaʻa below present-day Kōloa Town.

This system developed contemporaneously and in some cases earlier than the well-known valley field networks. Although the principles and the technology applied at Kōloa were similar to the valley networks, the challenging Kōloa landscape led to unique adaptations.

B. Environmental Parameters

Consideration of the local topography, climate, and soil characteristics suggest distinct advantages, in comparison to valley environments, for the development of Hawaiian agriculture in the *makai* region of Kōloa. First, there is thin soil over bedrock. This might seem to be a disadvantage but if it is recognized that this thin soil probably supported only thin rooted shrubs with parkland rather than dense forest, the heavy initial labor investment of vegetation clearing would be much less, compared to a densely forested valley environment.

Secondly, the solid *pahoehoe* basal rock, 20-30 cm under the silt loam soil, would have led to minimal loss of water through downward percolation, compared to a valley environment.

Thirdly, confined valley systems, particularly in the wet valleys of Kauaʻi, could be wiped out or severely damaged by seasonal flooding. In Kōloa, no such problem existed. The Kōloa system is an adaptation and response to the recurrent danger of loss of subsistence production due to flooding. The Kōloa field networks are developed above the flood plain on the well-drained lava plain of the Kōloa volcanic series.

In addition, Kōloa is a non-valley leeward environment. Solar radiation is higher than in most valleys and winter sun is not blocked by valley walls. Maturity periods for taro and other staples would be two to four months shorter than in valley environments.

C. Topography

The lava plain of Kōloa is not flat nor is it level. It shows long *mauka/makai*-oriented tongues formed of old lava flows. The *ʻauwai* were kept on these elevated points and could extend for long distances from the primary water source, Waikomo Stream. Some *ʻauwai* extended nearly 1.5 miles from the source and most originally extended to the ocean.

D. The Kōloa Field System as a Type

Riley (1975:102) and Kirch (1977) have outlined four types of irrigated fields found in Hawai`i. Type 1 is a simple set of parallel terraces with water flow down the center, overflowing each successive down slope terrace in turn. This is called a "barrage" type system and is considered the most simple. Type 2 involves the construction of an *ʻauwai* tapped from the stream which enters the top of a series of terraces. The *ʻauwai* ends at the upslope end of the terrace system as the water simply overflows down each successive terrace. Type 3 involves an *ʻauwai* paralleling the upslope side of the terrace feeding water to each row of fields. Each row has a separate tap from the *ʻauwai*. Type 4 involves two parallel *ʻauwai* on separate levels, one downslope from the other, each of which feeds water to separate rows of terraces. The lower *ʻauwai* serves as a drainage for the fields above it. This is considered the most highly developed type.

The Kōloa Field System fits none of the types described above. In its abstracted and simplest (and unintensified) form, the Kōloa field system consists of a series of parallel *ʻauwai* flowing either on both sides or on top of a lava flow (Figure 8). This kind of system would be impossible to construct in a valley environment without an impractical input of labor. It is uniquely adapted to the lava topography of Kōloa. There are no analogies in Hawaiian valleys. The only possible comparison could be to the extensive irrigation system at Lalamilo in Kohala on Hawaiʻi Island where the broad undulating topography required layout of *ʻauwai* and fields not typical of a valley environment. Another matter of importance is the sheer size of the Kōloa system. It is known now to have covered over 700 acres and may have been considerably larger before commercial sugar. This would make it one of the largest irrigated systems in the Hawaiian Islands.

Dendritic secondary *ʻauwai* branches – or a braiding pattern – would have been progressively added to the main *ʻauwai* as the system was intensified. Another form of intensification would be smaller fields.

Aqueducted or raised *ʻauwai* are one of the most intriguing phenomena of the system (Figure 9). These raised structures are likely labor-intensive responses to the need for more irrigated land in places where water must be routed over low ground. This effort involved the piling of hundreds of cubic meters of sediment and rock, but may have resulted in the ability to irrigate much more than an acre of land. This alone is testimony to the greater productivity of irrigated fields over non-irrigated fields.

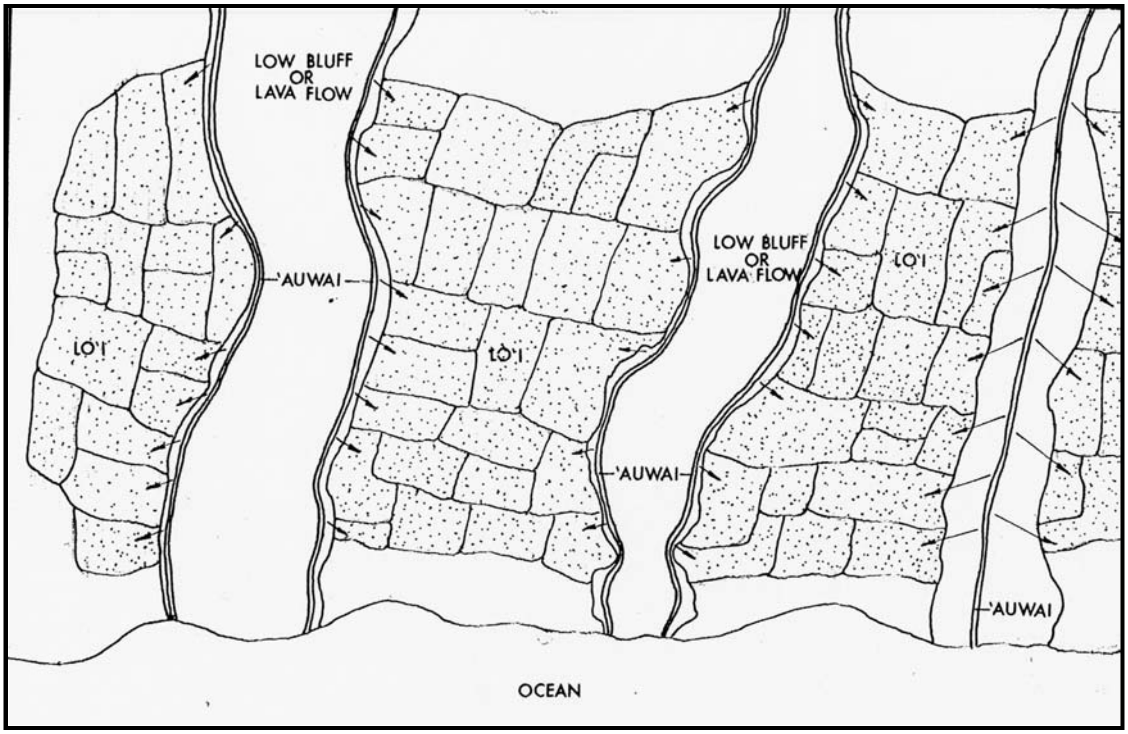

Figure 8. The Kōloa Field System: the basic type schematically represented

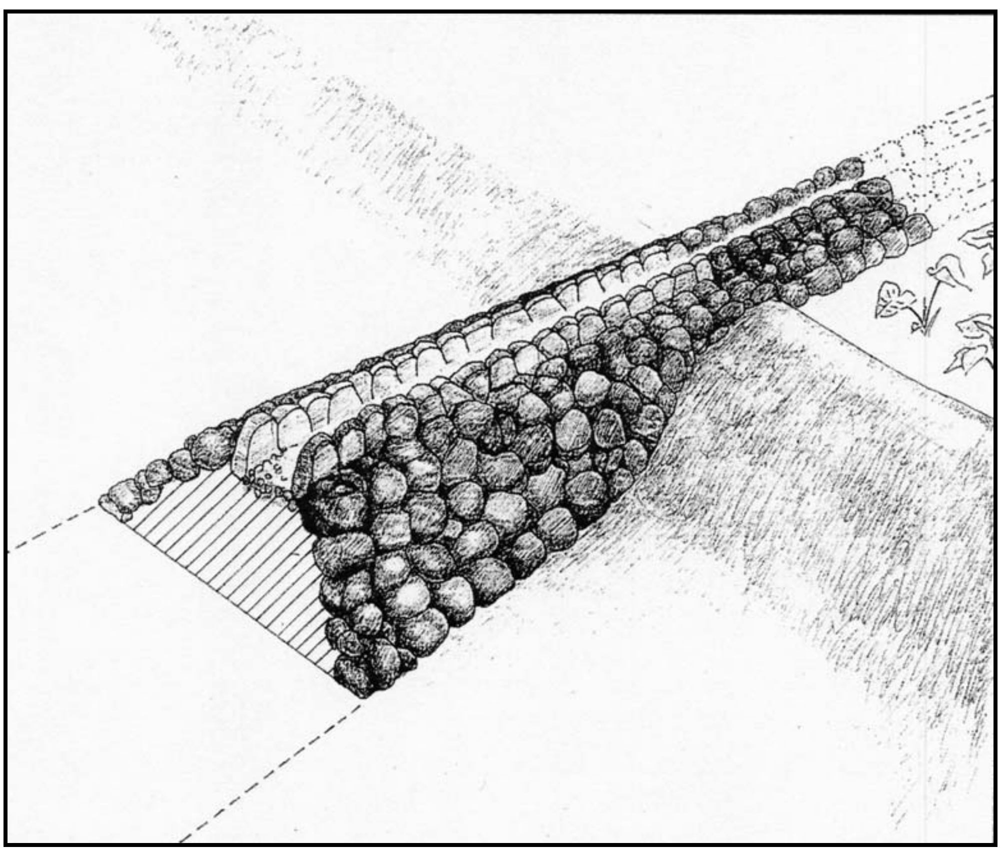

Figure 9 Cross section of a raised *'auwai* (irrigation ditch)

V. ARCHAEOLOGICAL RESEARCH

A. Archaeological Research in Kōloa

Figure 10 and Table 3 summarize previous archaeological projects in Kōloa Ahupuaʻa that may be relevant in understanding cultural practices and resources in the current project area.

Archaeological research before 1960 was limited to oral history accounts and surveys of the larger more important sites, especially coastal *heiau*. The first survey of an inventory nature of Kōloa resulted in a catalog of features for the general Kōloa region. The Lahainaluna Schools document lists 14 *heiau* and one fishing shrine in Kōloa Ahupuaʻa.

Thomas Thrum was the next to discuss sites in the Kōloa area in his list of the *heiau* of Kauaʻi. He noted six *heiau* in the district of Kōloa, which once extended from Hanapepe to Māhāʻulepu. The *heiau* were Hanakalauae, Kanehaule, Kihouna, Kaneiolouma, Weliweli (Weliweli Ahupuaʻa), and Waiopili (Mahaulepu Ahupuaʻa). The two *heiau* on the Kōloa coast, Kaneiolouma and Kihouna, were described as: "near the Poʻipū Beach, at Kōloa, are two walled heiau but a short distance apart" (Thrum 1907:36-37, 68).

Wendell Bennett conducted the earliest systematic archaeological survey of the island of Kauaʻi in the late 1920s. Bennett (1931:98) examined and recorded 202 sites on the island, some in the *ahupuaʻa* of Kōloa, including the Kihouna Heiau.

William Kikuchi (1963) conducted a general survey of the Kona District of Kauaʻi including all *ahupuaʻa* from Hanapēpē, eastward to Kīpū Kai. Information from a number of sources (Lahainaluna School document 1885; Thrum 1907; Bennett 1931) was instrumental in helping to locate major archaeological sites during the field survey. Kikuchi's survey was selective since it was not designed to be a complete inventory, and focused on larger or more coastal sites. No sites were near the present project area. Kikuchi did list sites that were not surveyed by him but were mentioned in other sources. In Kōloa, this included the *heiau* of Maulili.

During the 1973-1974 State Wide Inventory of Historic Places performed by the Archaeological Research Center of Hawaiʻi (ARCH) of the County of Kauaʻi for the State of Hawaiʻi, the archaeological remains first identified by Bennett (1931) (State Inventory of Historic Properties (SIHP) Site 50-30-10-85) were briefly evaluated and placed on "Reserve" status, meaning the sites needed to be saved until additional research could be carried out.

Stephen Palama and Catherine Stauder (1973) conducted a reconnaissance survey along the route of the then-proposed main cane haul road to the Kōloa mill site, running in between the small northern portion and main southern portion of the present project area. The proposed new section of road extended from Weliweli Road, southwestward across Poʻipū Road, connecting to an existing cane haul road. This road corridor crossed a portion of Weliweli Ahupuaʻa and both east and west Kōloa at a distance of between two-thirds to two miles from the coast. A total of 18 sites were recorded along the road corridor. Although the Palama and Stauder study was limited in scope to the proposed road right of way, it included a short but thorough historical summary of the place of archaeological sites within the context of the Kōloa and Weliweli Ahupuaʻa. An extensive *ʻauwai* system was observed east of Poʻipū Road. The following comments on this system and the sites in general are relevant to understanding the archaeological significance of the area as a whole, and the historic processes at work:

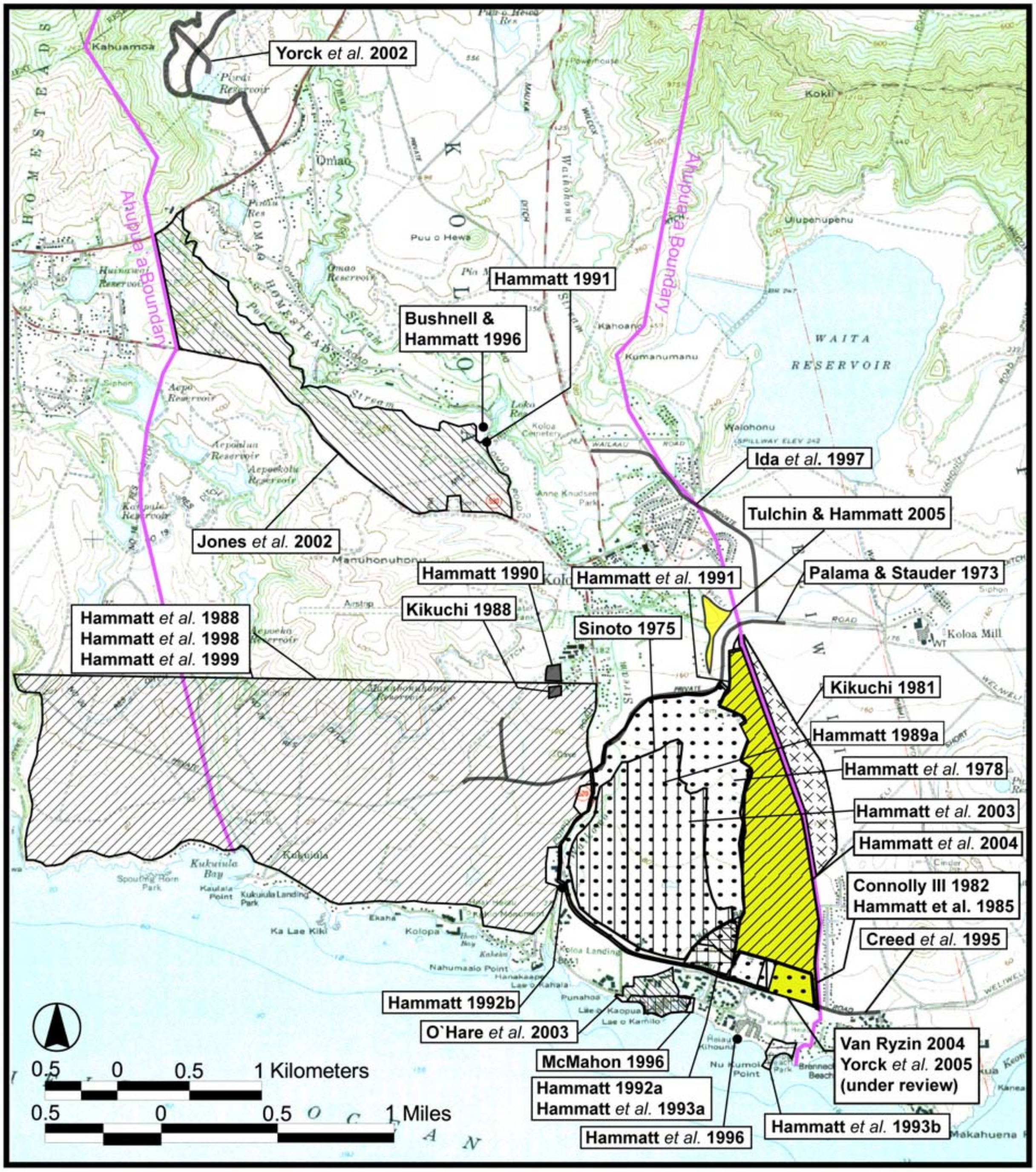

Figure 10. U.S. Geological Survey map, Kōloa Quad (2000), showing project area (indicated in yellow) and locations of previous archaeological studies

Table 3. Previous archaeological investigations in Kōloa Ahupuaʻa

NAME	YEAR	LOCATION	STUDY TYPE
Bennett	1931	Kukuiʻula Valley, Prince Kūhiō Park	General Survey
Kikuchi	1963	Kona District	General Survey
Kikuchi	1973	Hawaiian Fishponds	General Survey
Palama and Stauder	1973	Cane Haul Road-Kōloa Mill	Reconnaissance Survey
Sinoto	1975	Knudsen Trust Lands	Reconnaissance Survey
Bordner	1977	Kukuiʻula ʻAuwai, SIHP Site 50-39-10-1934	Reconnaissance Survey
Hammatt, Bordner and Tomonari-Tuggle	1978	Kiahuna Complex	General Survey
Kikuchi	1979	Sheraton Kauaʻi Hotel	Survey and Subsurface Testing
Kikuchi	1981	Weliweli Tract	Reconnaissance Survey
Connolly	1982	Kōloa-Poʻipū Bypass Road	Reconnaissance Survey
Ching	1983	Kukuiʻula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Landrum	1984	Kukuiʻula-Kualu, Alexander and Baldwin Lands	Reconnaissance Survey
Hammatt, Borthwick and Shideler	1985	Kōloa-Poʻipū Bypass Road	Survey and Subsurface Testing
Kikuchi	1985	Shoreline Improvements, Waiohai Hotel, Kiha Houna Heiau	Reconstruction
Kikuchi	1988	Paʻanau Sugar Camp	Reconnaissance Survey
Hammatt et al. (Hammatt, Borthwick, Shideler, and Stride)	1988	Kukuiʻula Bay Planned Community	Inventory Survey
McMahon	1989	Kauaʻi Fishponds	General Survey
Hammatt	1989a	Kiahuna Golf Club	Data Recovery and Preservation Plan
Hammatt	1990	Paʻanau Housing Project	Inventory Survey
Hammatt	1991	Pōʻele'ele Stream - Waterline crossing	Archaeological Reconnaissance
Hammatt, Folk, and Stride	1991	Pōʻipulani Golf Course	Inventory Survey
Hammatt	1992a	Kiahuna	Inventory Survey
Hammatt	1992b	Poʻipū Road and Lāwaʻi Road Junction	Archaeological Reconnaissance

NAME	YEAR	LOCATION	STUDY TYPE
Hammatt, Ida and Folk	1993a	Poʻipū Road 7.6-acre Parcel	Inventory Survey
Hammatt et al. (Hammatt, Ida, Folk, Shideler, and Colin)	1993b	Poʻipū Beach Park	Subsurface Testing and Monitoring
Creed, Ida and Hammatt	1995	Poʻipū Road	Inventory Survey
Bushnell and Hammatt	1996	ʻŌmao Bridge, ʻŌmao Homestead	Archaeological Investigation
Hammatt, Creed, and Ida	1996	Waiohai Resort	Assessment Survey
McMahon	1996	Sheraton Kauaʻi Hotel	Reconnaissance Survey
Ida, Creed, and Hammatt	1997	Poʻipū Bypass Road	Inventory Survey
Hammatt et al.	1998	Kukuiʻula Planned Community Phase I	Data Recovery
Hammatt et al.	1999	Kukuiʻula Planned Community Phase II	Data Recovery
Jones et al.	2002	260-Acre Parcel at \`Ōma\`o	Inventory Survey
Yorck, Shideler, and Hammatt	2002	Kaumualiʻi Highway, Alexander and Baldwin Properties	Inventory Survey
Tulchin and Hammatt	2003	Eric Knudsen Trust Lands	Field inspection
O'Hare et al.	2003	Sheraton Kauaʻi Hotel	Inventory Survey
Hammatt et al.	2004	Eric Knudsen Trust Lands	Inventory Survey
Van Ryzin & Hammatt	2004	Eric Knudsen Trust Lands	Data Recovery
Tulchin and Hammatt	2005	Eric Knudsen Trust Lands	Reconnaissance Survey
York et al.	2005	Eric Knudsen Trust Lands	Inventory Survey

> Our reconnaissance revealed that the most significant archaeological feature located within the study area is the extensive *ʻauwai* system. Remnants of this irrigation system were observed on both sides of Waikomo Stream . . . [This] network of watering canals proved to be the key to the success of the prehistoric Hawaiian Culture in turning these marginal lands into flourishing wet and dry agricultural fields. From information gathered from local informants and preliminary historical investigation of this area it is evident that the early commercial growers of sugar cane utilized the existing *ʻauwai* system. Gradually as more and more fields came under sugar cane production these replaced the wet and dry fields of an earlier day. Today the archaeological sites remaining stand as islands as these marginal cane lands were taken out of production and turned into pasture. (Palama & Stauder 1973:4)

A survey by the ARCH in 1974 was conducted in the area encompassed by the sewage treatment plant to the west of the project area. A portion of a large agricultural complex was recorded. Ching, Palama, and Stauder conducted a surface survey for the ARCH of coastal lands (approximately 1000 acres) of the *ahupua'a* of Weliweli, Pā'ā, and Māhā'ulepū (Ching et al. 1974). Several important sites--specifically the Waiopili Heiau complex--were located, however extensive bulldozing and stone robbing had destroyed most of the surface features, making spatial analysis impossible.

Akihiko Sinoto conducted a reconnaissance survey of 400-plus acres of Knudsen Trust Lands at Kōloa immediately to the west of the current project area. He recorded several features and suggested they were the northern remnants of Bennett's Sites 78, 79, 85 and 86. Sinoto located many sites with both habitation and agricultural features along the southern portion of the study area, from the sewage treatment plant to the Weliweli subdivision (Sinoto 1975).

In 1977, reconnaissance was undertaken to locate an *'auwai* that was reputed to run from Waikomo Stream to the area of the Prince Kuhio Hotel (Bordner 1977). A large *'auwai* was found, which corresponds to the major *'auwai* system assigned SIHP number 50-30-10-1934.

In 1978, ARCH conducted a survey of the Kiahuna area for Moana Corporation (Hammatt et al. 1978). A total of 460 acres of land was surveyed with extensive mapping and descriptive recording of a major complex of well-preserved nearly continuous and highly integrated agricultural and habitation features including long '*auwai* originating from Waikomo Stream.

William Kikuchi (1979) conducted a reconnaissance survey north of Po'ipū Beach Road. Kikuchi found agricultural features and concluded that the area lay within the coastal fringe part of the agricultural and habitation zone that extended inland all the way to Kōloa town. A tidal pool, a railroad berm, and several stonewalls were also recorded in the area.

Francis Ching (1983) conducted a reconnaissance survey, and an historical investigation of 230-plus acres of Alexander and Baldwin lands within the *ahupua'a* of Kōloa (west Kōloa) and Lāwa'i. According to Ching, three-fourths of the study area was bulldozed, with many rocks re-located, however, remnants of walls, *lo'i*, '*auwai*, terraces, and an historic railroad berm were still discernable. These remnants are evidence of the great expanse of the Kōloa Field System.

James Landrum of the Bishop Museum (1984), conducted a reconnaissance survey of a 200-plus acre portion of Kukui'ula. Landrum recognized that his survey area was once part of an extensive irrigated agricultural complex developed in the prehistoric period with superimposed historic-era occupation (Landrum 1984:24).

Hallett Hammatt, Douglas Borthwick, David Shideler, and Mark Stride conducted an archaeological inventory survey in the 1000-acre proposed Kukui'ula Bay Planned Community west of the current project area (Hammatt et al. 1988). Fifty-eight archaeological sites were recorded, many associated with the Kōloa Field System. Two to three *heiau* were found, including the remains of Kamaloula Heiau.

William Kikuchi (1988) conducted a reconnaissance level survey of the former Pa'anau Sugar Camp, west of the present project area. The camp was located just *makai* of the present day Kōloa Elementary School. The survey recorded a number of cement foundations, ditches, and portable historic artifacts. Kikuchi states that archaeologically the site is interesting because it contains remnants of an early (1910-1950) plantation camp, even though the vast majority of its structures have been destroyed or removed.

Hallett Hammatt (1990) conducted an inventory survey of a 4.7-acre parcel at the west end of Pa'anau Road near Kōloa town, west of the present project area. The historical segment of this report indicates the previous existence of the Pa‘anau Camp, and a railroad and ‘*auwai* irrigation ditch which traversed the study area. However, the survey revealed the absence of any traces of pertinent features.

Hallett H. Hammatt (1991) carried out an archaeological reconnaissance for a proposed waterline stream crossing of Pō‘ele‘ele Stream, north of Kōloa town, a significant distance to the northwest of the present project area. He noted extensive modern land modification and no significant findings.

Hallett H. Hammatt, William Folk, and Mark Stride (1991) conducted an archaeological inventory survey of 160 acres along the Kōloa-Weliweli Ahupua‘a boundary. They located, mapped, described, and evaluated 75 sites and observed a wide range of site types. Their survey indicates that the Po‘ipūlani project area was associated with the Kōloa Field System. The study overlapped a large section of the main northern portion of the current project area. Within this agricultural field system 75 intact archaeological sites remain on the property. The sites are categorized as (8) permanent habitation sites, (31) temporary habitation sites and (16) ‘*auwai*. Other sites categorized include agricultural sites, burials sites, and historic era sites. The agricultural sites consist of clusters of adjacent fields which are defined by low field boundary walls, earthen mound, and high stacked boulder walls. The burials sites are relatively few sites within the project area which appear to have exclusive function as burials structures and generally burial sites do not figure prominently in the Kōloa fields. The historic sites consists of a rectangular house site and a large enclosing wall, correlated to one of the 19th Century LCAs and appears to be largely historic in age.

Hallett H. Hammatt (1992a) carried out an archaeological inventory survey of a 3.8-acre property at Kiahuna (TMK 2-8:014-026), but the entire parcel had been previously graded and there were no significant findings. This project is bounded by Po‘ipū Road on the southeast and overlaps the southwestern tip of the current project area.

Hallett H. Hammatt (1992b) carried out an archaeological reconnaissance of the Po‘ipū Road and Lāwa‘i Road Junction near the mouth of Waikomo Stream, west of the current project area, but again there were no significant findings, owing to prior land disturbance.

Hallett Hammatt, Gerald Ida, William Folk, David Shideler and Brian Collin (Hammatt et al. 1993b) conducted an assessment survey, subsurface testing, and monitoring at Po‘ipū Beach Park in the *ahupua‘a* of Kōloa, south of the current project area. Wave action during Hurricane ‘Iniki in 1992 had exposed a cultural layer (SIHP Site 50-30-10-745) which needed to be preserved and monitored during the reconstruction and restoration of the park. Auger testing revealed charcoal, and both traditional and historic midden and artifacts (i.e. basalt flakes and fragments, nails, glass, *kukui* shells, and mollusk shells) (Hammatt et al. 1993b:11). An historic cemetery (SIHP Site 50-30-10-1871), located in the middle of Po‘ipū Beach Park, and other sections of the buried cultural layer beneath the park, were also monitored during the removal of several cement slabs, remnants of a pavilion, picnic tables, and barbecues. Three radiocarbon dates were determined for this layer: the earliest was A.D. 1282-1414 and the latest ranged from A.D. 1678-1940 (Hammatt et al. 1993b:52). The rich cultural layer, supported by radiocarbon dating, indicates that this shoreline occupation is contemporaneous with the development of the Kōloa Field System. This cultural layer is the “single largest coastal beach deposit in the *ahupua‘a*..of Kōloa” and greatly contributes to the information bank regarding the cultural development of the Kōloa district (Hammatt et al. 1993b:65, 66).

Victoria Creed, Gerald Ida and Hallett H. Hammatt (1995) reported on an inventory survey within a 1.4-mile corridor along the *mauka* side of Po‘ipū Road (TMK 2-8-15, 16, 17 & 18) in the *ahupua‘a* of Kōloa and Weliweli, south of the current project area. Three sites, including enclosures, a terrace, and the Kōloa-Weliweli boundary wall, survived previous bulldozing of the area and were understood as components of the Kōloa Field System.

Kristina Bushnell and Hallett H. Hammatt (1996) carried out an archaeological investigation of ‘Ōmao Bridge in ‘Ōmao Homestead, northwest of the current project area. The only objects of historical interest noted were the existing bridge and features associated with an old railroad.

Hallett Hammatt, Victoria Creed, and Gerald Ida (1996) conducted an assessment survey of an exposed cultural layer in undisturbed sand deposits at Waiohai Hotel, south of the current project area. This layer was disturbed by high wave action during Hurricane ‘Iniki, which completely destroyed the associated reconstructed Kihouna Heiau (SIHP Site 50-30-10-80). Three charcoal samples from this layer were dated to A.D. 1430-1950. The exposed cultural layer supports the potential existence of widespread intact cultural areas along the general shoreline (Hammatt et al. 1996:36, 39).

Nancy McMahon (April 1996), at the time an independent archaeological consultant, completed a reconnaissance survey southwest of the current project area. The purpose of the survey of TMK 2-08-16:3 (8.444 acres), part of the Sheraton Kaua‘i Resort, was to report on damage caused by Hurricane ‘Iniki. No surface sites or cultural deposits were reported. She noted a sandy deposit up to the foundations of the buildings on the eastern side of the project area near Lae o Kamilo. She suggested that the remnants of beach dunes could still exist and recommended monitoring of any construction in this area in case historic sites, including human burials, were uncovered.

Beginning in December of 1996, reconstruction of areas damaged by the hurricane began at the Sheraton Kaua‘i Hotel (McMahon 1996). Excavations took place to construct new buildings on new concrete pads. An intact cultural layer, designated Layer III was uncovered. The cultural layer, Layer III, was a dark sandy layer. After grading of one Pad area was complete, human skeletal remains were found in the excavated material. During monitoring of the rest of the project, a total of ten subsurface features (Features B-K) were discovered. Six were fire pits; one was a stain; one was a concentration of fire-cracked rocks; one was a C-shaped structure; and one was a pig skeleton. Eight burials were also uncovered within Layer III. Six charcoal samples were submitted for radiocarbon age determination for Layer III. These ranged from 20+/- 70 BP (before present) to 540+/- 60 BP, indicating that the earliest possible date for the features was A.D. 1400. The site was west of the current project area.

Gerald Ida, Victoria Creed and Hallett H. Hammatt (1997) conducted a reconnaissance survey on a 1.2 mile corridor of a proposed bypass road within the *ahupua‘a* of Kōloa and Weliweli (TMK 2-8-02:3, 2-8-03:1, 2-8-04:1, 2-8-05:2) that had previously been bulldozed. This road extended from an existing bypass road at the coast to north of Kōloa town, north of the present project area. This survey did not reveal any archaeological sites, and further study was not recommended.

CSH reported on data recovery of the Kukui‘ula Planned Community Project Phase One area encompassing approximately 219 acres (Hammatt et al. 1998). The project included excavations at 20 different sites, which encompassed 64 individual features. There were a total of 212 excavation units (212 m^2) and 19 backhoe trenches (only 14 backhoe trenches were chosen for study). Large quantities of midden (approximately 23.7 kg) and artifacts (10,635 items) were recovered and are reported on. The artifacts include a wide range of types with both indigenous (2,592 items) and historic (8,043 items) represented. Radiocarbon (C14) dates ranged from ca. A.D. 1050 onward. The earliest date came from the habitation/burial cave SIHP Site 50-30-10-1927A. In addition to the habitation sites and features dated, seven dating samples from agricultural features were also analyzed. The study is north/northeast of the present project area.

CSH reported on data recovery work just *makai* and southwest of Kōloa Town on the west side of Waikomo Stream in the northeastern portion of the Kukuiʻula Planned Community Phase II Area (Hammatt et al. 1999). The study area is comprised of approximately 33 acres and has been used as a buffer zone between cane lands/pastures and the residential lots bordering Poʻipū Road. While some ten Land Commission Awards lies partially or entirely within the project area, most of these properties were bulldozed in the course of sugar cane cultivation. There were, however, areas that appeared undisturbed by sugar cane cultivation or heavy machinery. Excavations were conducted within five archaeological sites (13 features). These excavations yielded 264.8 g of midden; 53 indigenous artifacts (including 43 volcanic glass flakes, 9 basalt flakes, and one coral manuport); and 877 late-historic artifacts (e.g. glass, metal, ceramics, plastic, leather, and slate). Twelve charcoal samples were dated, and ranged from A.D. 1250-1410 to A.D. 1800 to present. This study lies west of the present project area.

Jesse Yorck, David Shideler, and Hallett Hammatt (2002) conducted an inventory survey of three proposed well sites near Pīwai Reservoir north of ʻŌmao Homesteads, located a significant distance northwest of the current project area. No archaeological sites were identified in the project area or vicinity.

In 2003, an archaeological survey was conducted along the coast in the Sheraton Kauaʻi Hotel property, southwest of the current project area (O'Hare et al. 2003). Saltpans, abraded areas, and possible bait cups were recorded along the rocky coast. These may correspond to Bennett's Site 76 described as, "Salt pans, east of Waikomo Stream along the shore" (Bennett 1931:98). Five features were noted in the interior section of the project area, two platforms, one mound, one terraced area, and one enclosure. The two platforms were later partially dismantled to test for burials. No human remains or any other cultural materials were recovered from the features.

B. Summary of Archaeological Research Specific to the Current Project Area

Locations of archaeological investigations conducted within the project area are shown in Figure 11. Descriptions of these investigations are presented below.

In 1991, Hallett H. Hammatt, William Folk, and Mark Stride conducted an archaeological inventory survey in support of the proposed Poʻipūlani Golf Course project (Hammatt et al. 1991), which included the previously surveyed Kiahuna Golf Village project (Hammatt et al. 1978). This report was reviewed and accepted by SHPD along with a data recovery and preservation plan for the property (Hammatt 1991). A total of 75 sites were located and described, including structures of both habitation and agricultural function associated with the large irrigated agricultural and habitation complexes described by Hammatt et al. (1978). Sites previously identified in the Kiahuna Golf Village and Kōloa-Poʻipū Bypass Road projects were relocated and assigned State site numbers. Preservation was recommended for "major sites," and "all other sites which cannot be incorporated into the development should be subjected to a program of data recovery including subsurface testing and excavation" (Hammatt et al. 1991).

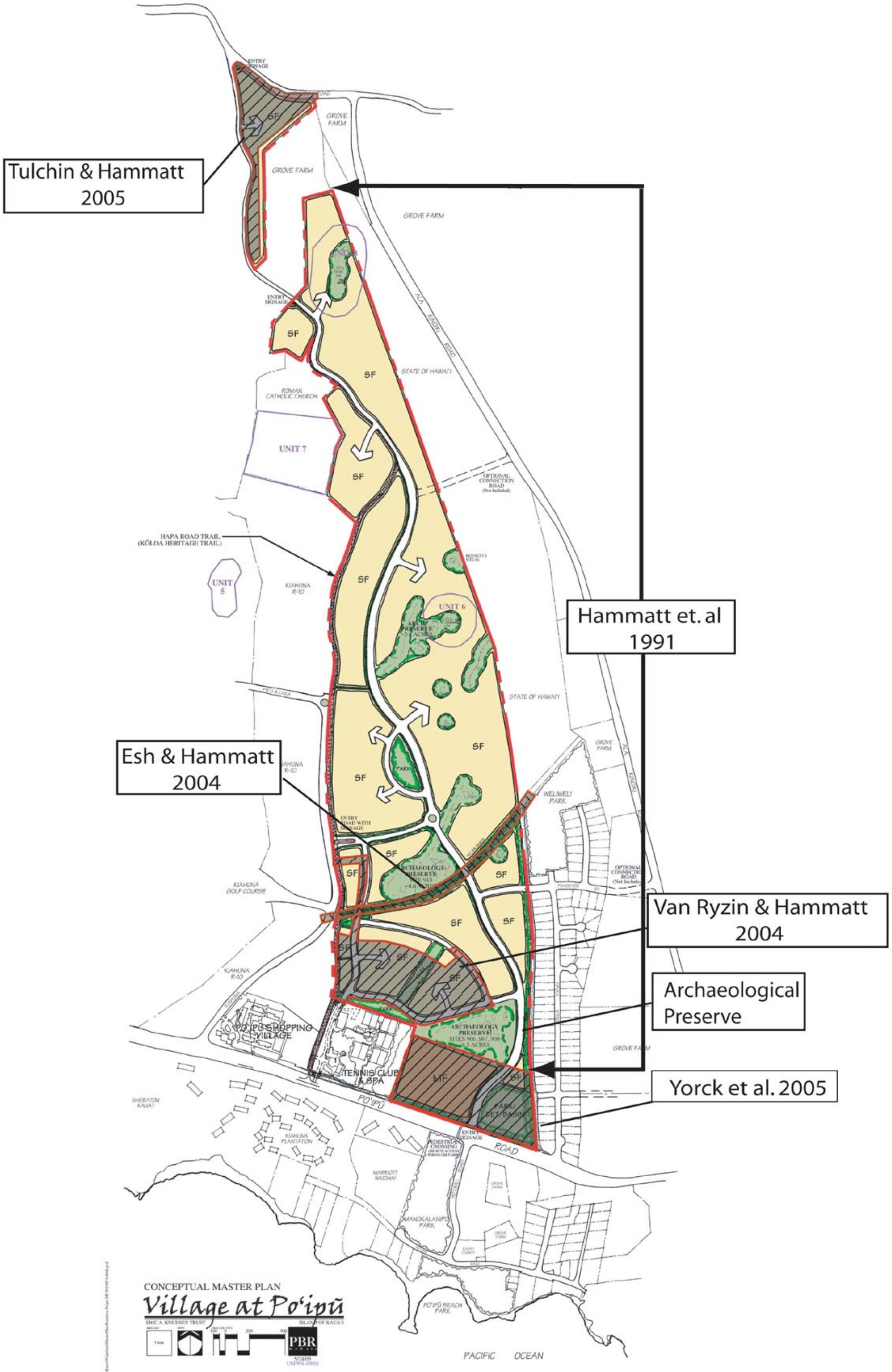

Figure 11.Archaeological Investigations within the Village at Po'ipu project area

In 2004, Cultural Surveys Hawai‘i Inc. completed an archaeological inventory survey, with subsurface testing of a 7.6-acre parcel (TMK 2-8-14:30) at Kōloa, Kaua‘i (Hammatt et al. 2005).

The project area has been the subject of three earlier studies (Hammatt et al. 1978; Hammatt 1992a; Hammatt, Ida, and Folk 1993a). The archaeological studies identified and documented eight sites in or bordering the project area: SIHP sites 50-30-10-539, 50-30-10-540, 50-30-10-541, 50-30-10-947, 50-30-10-992, 50-30-10-3756, 50-30-10-3757, and 50-30-10-3758. Test excavations conducted during these earlier surveys evaluated the significance of C-shape features, platforms, mounds and walls and determined they were used for permanent and temporary habitation-type activities in pre-contact times. This site complex, although presently isolated by modern alteration to the land, was once part of the huge 400-plus acres of land east of Waikomo Stream, between present day Kōloa town and the sea. Based on earlier archaeological research, five sites in the project area were recommended for preservation (-947, -992, -3756, -3757, and -3758) and three sites for no further work (-539, -540, and -541).

In 2004, CSH completed a data recovery project within the Village at Po‘ipū, Phase 1 Project Area at Kōloa Ahupua‘a, Kona District, Island of Kaua‘i (TMK: 2-8-14:19 por.) (Van Ryzin and Hammatt 2004). The data recovery was for four SIHP sites, 50-30-10-908, -909, -969, and -973.

Testing in SIHP Site -908 produced a limited amount of artifacts, midden and charcoal. A total of 3.8 g of midden, one basalt flake, and a few pieces of charcoal were recovered during excavation. Such a small amount of cultural material suggests that the site was used temporarily, and not for an extended period of time.

No cultural materials were observed during the testing of SIHP Site -909. The lack of cultural materials suggests that this site was used temporarily and not for an extended period of time.

No cultural materials were encountered during the testing of SIHP sites -969 and -973, which is not uncommon for ‘*auwai* features. Despite the lack of charcoal, the construction of the ‘*auwai* sites suggests they were constructed and utilized during pre-contact times

In 2005, CSH conducted an archaeological inventory survey of an approximately 18-acre parcel, known as the *makai* portion of parcel 19 of the Eric Knudsen Trust Lands located in Kōloa Ahupua‘a, District of Kona, Island of Kaua‘i (TMK 2-18-14: por. 19) (York et al. 2005). Sixteen historic properties were identified in the project area, 15 were previously recorded (SIHP sites 50-30-10-3766, -3769, -3770, -3771, -3775, -3779, -3785, -3790, -3791 -966, -3896, -3897, -3898, -3899, -3900), and one was newly identified (SIHP Site 50-30-10-3905).

Of the 16 located sites, ten have a habitation function, three have an agricultural function, one has a storage function, and one is a probable *ahupua‘a* boundary. Site complex -966 has both an agricultural and habitation function.

Six test units were excavated at five sites (-3766 A, -3770 A&B, -3785, -3791, -3905). Moderate amounts of inner coastal shell midden and scant amounts of small mammalian and avian bone were collected from the excavation units. In addition, four volcanic glass flakes, one basalt hammerstone, and charcoal were collected from the six test units.

The material finds recovered during the survey are indicative of an agriculture field with associated habitation and temporary habitation. Though material evidence of historic occupation was not encountered during the inventory survey, the Kōloa area is known to have been heavily modified to allow commercial agriculture (e.g. sugar cane and victual trade goods) and extensive ranching in the historic era.

In March 2005, CSH conducted an archaeological literature review and field inspection of the 8.5 acre parcel comprising the *mauka*-most portion of the present project area (Tulchin and Hammatt 2005). During the field inspection, the parcel was observed to include open pasture in its southernmost portion and more dense vegetation – including *koa haole*, sisal, java plum trees, Chinese banyans, and tall grasses – in the northern, triangular-shaped portion. Three historic properties were observed in the parcel: an historic irrigation flume and two raised rectangular platforms constructed of basalt boulders.

VI. PLACE NAMES IN AND AROUND THE KŌLOA PROJECT AREA

Unfortunately, over time, traditional Hawaiian names for specific land areas, land features, and ocean areas become lost to living memory. Even those names that survive on topographic maps are often supplanted by modern place names having no traditional association with an area.

During the course of the investigations for this cultural impact assessment, Cultural Surveys Hawaiʻi has researched nineteenth-century documents that have recorded traditional Hawaiian names for *ʻili*, land subdivisions within an *ahupuaʻa*, within the present Kōloa project area that are no longer identified on maps or are no longer in general use in the area. The documents include an 1891 government survey map of Kōloa by M.D. Monsarrat (see Figure 3) and mid-nineteenth century Land Commission Award (LCA) records (see discussion in Section III D and Section III E above). In testimony for a land award, a claimant and the witnesses for the claimant will identify the *ʻili* in which the claimant's land is located. Typical examples from the LCA records for parcels within and adjacent to the Kōloa project area include:

> Kaanaana, sworn, says, I know Pehu's land in "Koloa Hikina." It consists of three lois and a kula in one piece. It is in the ili of "Kapalaalaea." Also a house lot in the ili of "Waiohai." (Kaanaana testifying for LCA 3415 to Pehu; Foreign Testimony vol. 13, pg. 15)
>
> Poohina, sworn, says, I know the Claimant's land. It is eight lois and a kula in the ili of "Keaku" Koloa, Hikina. (Poohina testifying for LCA 3619 to Kahukini; Foreign Testimony vol 13, pg. 22)
>
> I hereby state my claim for land . . . [The loʻis] at Kamaemae are bounded by Kikiola on the north, by Weliweli on the east, by Kioea on the south, by Kapalaalaea on the west. (Kenoi testifying for his LCA 3601; Native Register vol. 9, pg. 69)
>
> Walewale sworn I know the land of Lae consisting of 9 lois and a house lot in the ili of Waiohai East Koloa. (Walewale testifying for LCA 3268 to Lae; Native Testimony vol 13, pp. 15-16)

Based on the locations of the LCA parcels, the corresponding *ʻili* names for these locations are shown within and surrounding the Kōloa project area on Figure 12. The map also includes additional *ʻili* names recorded on the 1891 Monsarrat survey map. The density of *ʻili* names within and surrounding the project area suggests the close, intimate identification of the Hawaiians with the specific land area in which they lived and worked.

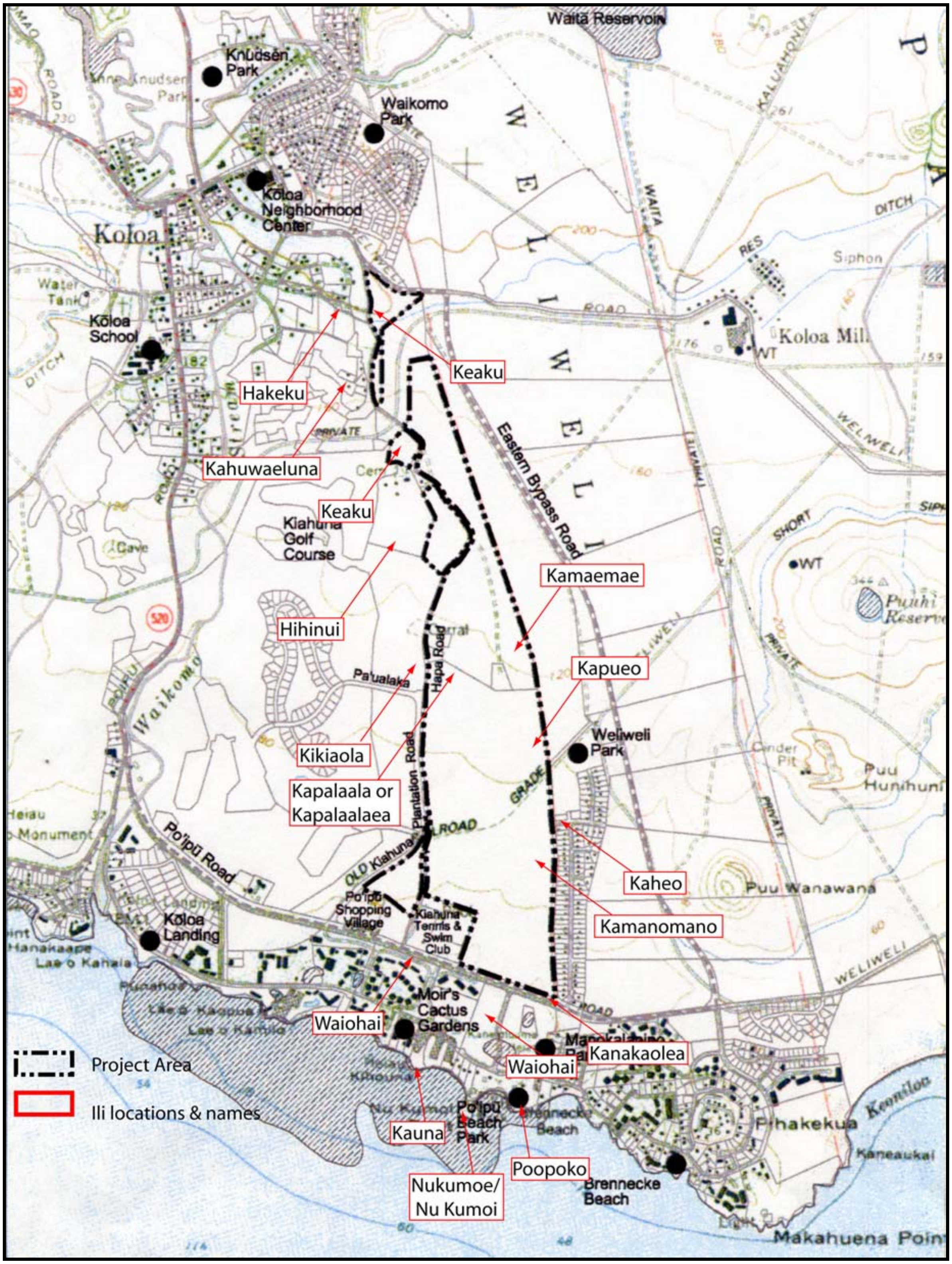

Figure 12. U.S. Geological Survey map, Kōloa quadrangle (2000), with approximate locations of *ʻili* names indicated

VII. RESULTS OF COMMUNITY CONTACT PROCESS

Throughout this course of this study, an effort was made to contact and consult with Hawaiian cultural organizations, government agencies, and individuals who might have knowledge of and/or concerns about traditional cultural practices specifically related to the project area. This effort was made by letter, e-mail, telephone and in person contact. In the majority of cases, letters along with a map of the project area were mailed with the following text:

> At the request of Eric A. Knudsen Trust, Cultural Surveys Hawai‘i is preparing a cultural impact assessment for the proposed development of 250 acres of the Knudsen Trust lands in the *ahupua‘a* of Kōloa on the island of Kaua‘i. The study area is shown on the enclosed maps. Most of this land is former pasture land that due to its rockiness was not converted to sugar cane as were most of the surrounding properties.
>
> The purpose of the cultural impact assessment is to assess potential impacts to traditional cultural practices as a result of future development of the 250-acre property.
>
> We are seeking your *kōkua* or help and guidance regarding the following aspects of our study:
>
> General history and present and past land use of the project area.
>
> Knowledge of cultural sites which may be impacted by future development of the project area - for example, historic sites, archaeological sites, and burials.
>
> Knowledge of traditional gathering practices in the project are – both past and ongoing.
>
> Cultural associations of the project area, such as legends and traditional uses.
>
> Referrals of *kūpuna* or elders who might be willing to share their cultural knowledge of the project area and the surrounding *ahupua‘a* lands.
>
> Any other cultural concerns the community might have related to Hawaiian cultural practices within or in the vicinity of the project area.

The individuals, organizations, and agencies we attempted to contact and the results of any consultations are presented in Table 4 below. Cultural Surveys Hawai‘i Inc. starts out with a list of community contacts and then follows up on their referrals.

Table 4. Community Contacts

Name	Affiliation, Background	Comments
‘Ahahui O Ka‘ahumanu Kaua‘i Chapter		No response.
Andrade, Manuel	Rancher	No concerns at this time.

Name	Affiliation, Background	Comments
Kapaka-Arboleda, La France	Office of Hawaiian Affiars, Community Resource Coordinator/Kaua‘i/Ni‘ihau Island Burial Council, Chairperson	Referred to Isaac Kaiu, Stella Burgess, Elizabeth. Bukoski, Samuel Bukoski, Manuel and Abel Mederios, James Kimokeo, Henry Kaohelaulii and his nephew James, and Nancy McMahon.
Ayau, Edward Halealoha	Hui Mālama I Nā Iwi O Hawai‘i Nei, Chair	No response.
Bukoski, Elizabeth	Life long Kōloa Resident	See interview in section VIII.
Burgess, Stella	Hyatt Hotels & Resorts, Cultural Specialists	No concerns at this time.
Carbonel, Albert	Grounds Facilitator for Queen Lili‘uokalani Children Center	No response.
Chang, David	Local Historian of Kōloa	See interview in section VIII.
Gage, Reginald	Board of Directors of Kaua‘i Historical Society	See interview in section VIII.
Guth, Heidi	Office of Hawaiian Affairs	Referred to La France Arbeleda
Higa, Nani	Halau Hula O Nani, *Kumu Hula*	No concerns at this time.
Jacinto, Louis	Life long Kōloa resident, former Kōloa Sugar Company employee	No response.
Kaiu, Issac	*Kama‘āina, Kupuna*	No response.
Kaohelauli‘i, Billy	*Kama‘āina* of Kōloa	See interview in section VIII.
Kaohi, Lionel	Association of Hawaiian Civic Clubs-Kaua‘i Council President	No cultural concerns at this time.
Kauwe, Chris	Cultural Practioner, *Kanaka Maoli* of Hui Mālama Kāne I Olo Uma.	See interview in section VIII.
Kimokea, James	*Kama‘āina*	No response.
Keli‘ipio, Sheryl	Ho‘o Lāhui	No response.
Knudsen, Eric C.	Knudsen Family	No response.
Lauretta, Mike	Department of Land and Natural Resources-Kaua‘i Land Division	No concerns at this time..
McMahon, Nancy	State Historic Preservation Division-Kaua‘i Archaeologist	No concerns at this time.
Medeiros, Abel	Kōloa Resident, Rancher	No response.
Medeiros, Manuel	Kōloa Resident	No response.
Moir, Beryl	Resident	No response.

Name	Affiliation, Background	Comments
Napōka, Nathan	State Historic Preservation Division-History and Cultural Branch	No comment at this time.
Perry, Warren	Royal Order of Kamehameha, Kaumualiʻi Chapter No. 3	No response.
Requilman, Mary	Kauaʻi Historical Society	No response.
Rowe, Rupert Napopoloakāne	*Kamaʻāina* of Kōloa, Puni Family	Consulted on Jan. 5, 2005
Tsuchiya, Rick	Kauaʻi Historic Preservation Review Commission	Recommended the following: That the applicant consults with the State Historic Preservation Division (and Burial Council), the Department of Hawaiʻi Homelands and the Office of Hawaiian Affairs; that a community input program (e.g. flyers, notices, meeting with community association, etc.) be initiated by the applicant to obtain information on cultural practices or resources in the project area; that opportunities for further consultation with the KHPRC occur as this project progresses; that individual KHPRC members contact CSH directly with the names of *kūpuna* in the area who may participate in the consultation process; that Beryl Moir and Abel Mederios be contacted as potential additional sources of information.
Yagodich, Darrll	Department of Hawaiian Homelands-Planning Office	No concerns at this time.

VIII. COMMUNITY INTERVIEWS

Presented below are summaries and excerpts of the six community informant interviews conducted for this cultural impact assessment. The summaries and excerpts focus on the information in the interviews most pertinent to land uses and traditional cultural resources, practices and beliefs related to the Knudsen Trust Lands project area.

A. Chris Kauwe

Chris Kauwe was born on September 12, 1956 to Clifford Kauwe and his wife Irene Kekoanui Patterson. Mr. Kauwe is a current resident of Kōloa and a cultural practitioner who teaches the traditional art of surfing on the beach at Pōʻipu. He is a member of "Hui Malama Kāne I Olo Uma", a group of *kamaʻāina* or native- born who perpetuate the culture of Hawaiʻi. The group's members are presently caring for the lands and cultural sites used by early Hawaiians just *mauka* of Pōʻipu Beach Park behind Brennecke's Restaurant bordered by Pōʻipu Road. On January 5, 2005, Mr. Kauwe participated in an interview conducted by Cultural Surveys Hawaiʻi Inc. at Pōʻipu Beach Park.

Asked about identification of native plants in the project area, Mr. Kauwe mentioned:

> *I am a cultural practitioner in the traditional arts of* lapaʻau *or healing,* lua *or hand to hand fighting, and* heʻe nalu *or surfing. My* kumu *or teachers are Levon Ohi, Ohai, Olohe Mitchell Eli, and the late Mahi Poi Poi. Many of the native herbs used in my practice of* lapaʻau *are gathered from within the proposed project area and are useful in healing various internal and external illnesses of the body. These native plants include the* popolo *used to heal respiratory illnesses,* kinehe*, used for cleansing and the "up-right"* ʻilima *for medicine and lei- making.*

Mr. Kauwe believes that the sites in the project area were once continuous with the sites his group is caring for:

> *Until recent bulldozing, my friends and I have taken meditative walks through the proposed project area. We have seen what is left of the ancient dwellings of the* kanaka *(ancient) or people who once used the area. The area still contains remnants of rock walls, platforms, rock-floored house sites, c-shaped rock formations, and standing mounds which indicate obvious signs of* kanaka *habitation.*
>
> *I have walked during solitary spiritual meditations on top of a long rock mound located in the present project area, perhaps eight feet or ten feet high which runs towards Kōloa Landing and the opposite end runs toward Haupu. I have recently learned the mound is the old railroad berm. From this high vantage point I have seen many cultural sites and evidence of an ancient* ʻauwai *or irrigation systems which run through the project area and go across the Pōʻipu Road into the area which myself and others are caring for. We believe that the sites in the project area are connected to the sites* makai *which we are caring for.*

Mr. Kauwe mentions that foot trails can still be found:

> *I have used the foot trails from the adjoining sub-division of Weliweli Tract which leads to the adjoining project area. In the summer of 1996, I spent many weekends mapping the area with Pete and Naomi Parker. We saw firsthand the remains of untouched dwelling sites in the area.*

When asked about impacts to cultural sites and practices in the project area Mr. Kauwe voiced his concerns:

> *My main concerns include flooding of lower lands, water runoff polluting our fishing and surfing grounds, loss of medicinal plants, removal of moss rocks which are the last identifying markers to ancient Hawaiian habitation sites, loss of open quiet spaces important in meditation to all cultural practitioners, over-population, and most importantly the impact to the land which myself and the members of Hui Malama Kāne I Olo Uma are so diligently caring for, not to mention the unidentified cultural artifacts that should remain in place.*

B. Reginald Gage

Reginald Gage was born in Chicago, Illinois in the year 1935 to Reginald Gage and Evelyn Gage. His parents came to Hawaiʻi during WW II, and he followed after the conclusion of the war in 1945 aboard the SS Lurline. Mr. Gage was raised in Mānoa and Kahala and later graduated from the University of Hawaiʻi Mānoa with a Bachelor's Degree in Business Education. After working several years on the island of Maui he became an appraiser. He was later offered the job of Chief Appraiser for the County of Kauaʻi. Mr. Gage came to Kauaʻi in 1968 and has been here ever since, living in the Kōloa (Kona) District and in Kalāheo. Mr. Gage serves on the Board of Directors of the Kauaʻi Historical Society.

When asked about Hawaiian place names specifically in Kōloa, Mr. Gage remembered:

> *I believe Kōloa got its name from the ducks. There was a wetland in back of Kōloa in ancient history. The wetland was drained by Kōloa Sugar and some of it was dammed to make the Waipā Reservoir, but much of the wetland was drained. Prehistorically there were many ducks in Kōloa. The people from McBryde Plantation think* kō *is cane and* loa *is long, they think it means "long cane", but I think it is historically inaccurate. I have read about the steep rock (Pali-O-Kōloa) on the east bank of the Waikomo Stream in Thrum's Hawaiian Annual. There is supposed to be a petroglyph on it and also a picture, but I have never seen it.*

Mr. Gage mentioned that there are legends associated with Kōloa:

> *Frederick Wichman is the guy who wrote about Kauaʻi legends. His grandfather was Charlie Rice, and he wrote an early text on legends. Wichman used to collect those kinds of things and other books. So Wichman would be an excellent source for the legends. He and I sit on the Board of Directors for the Kauaʻi Historical Society. He is the President of the Board, and I am Vice-President.*

Regarding cultural practices within the project area, Mr. Gage noted:

> *I have not witnessed any gathering of resources or cultural practices by Native Hawaiians or other ethnic groups during my lifetime other than the cultivation of sugar cane. Prehistorically, Kōloa was an area inhabited by the Hawaiians, and they used it for agriculture, not in the sense as we think of agriculture today, because it was a dry area. All throughout the Kōloa region there were* ‘auwai. *The* ‘auwai *were bringing water into the Kōloa area. I think Kōloa was primarily used to grow sweet potato and dryland taro. Primarily sweet potato was grown with* ‘auwai *bringing in water to the fields and the water coming from Waipā and Waikomo streams.*

Asked about his knowledge of any cultural sites, trails or burials within the project area Mr. Gage stated:

> *I have concerns as far as Knudsen, the proposed development. This is an area that has been under pressure for development for a long period of time now. Much of this area has been already developed in one way or another. For years the Knudsen Lands had cattle running on it. So a lot of the archaeological sites I think are maybe destroyed or lost or at least hidden. It is also an area that because it was rocky it did not have much urban pressure coming on to it, so because of that it is kind of preserved because people do not like* pōhaku, *except for walls. There could be sites unknown and undiscovered within the project area, and that is the job of you folks.*
>
> *I am not aware of any* heiau *in the project area. I kind of know roughly where the locations are in the Kōloa area. There are good* heiau *records in* Thrum’s Hawaiian Annual. *The Lahainaluna School* [manuscript] *is also a great resource, because we found some place names that were lost.*
>
> *The oldest dated archaeological site is at the border of Pā‘ā and Māhā‘ulepū in the sinkhole. That is the oldest dated environmental site in Hawai‘i. On the McBryde side there is habitation cave. It was used for Civil Defense for a long while as a storage site. That shows on the archaeological map. In back of Prince Kūhio Park there were habitation caves. Small caves, they are only maybe ten feet long or so. I believe Hal Hammatt conducted that study.*
>
> *Historic sites, obviously there is the mill that Ladd & Company built. The old sugar mill is a ruin now. It goes across the road. You can see foundations across the road. The Roman Catholic Church, St. Raphael founded by Father Walsh in 1841, would be another historic site.*
>
> *I know a great deal about caves in Kōloa because of my work with Storrs Olson, a curator of birds at the Smithsonian Institution. He is an ornithologist. We have searched the caves in Kōloa for bird remains and looking back I cannot recall ever having seen a burial in Kōloa, except along the shorelines. There were many burials along the shorelines, but not in caves. I think the Kōloa caves were most likely used for habitation rather than burials.*

> *Kauaʻi trails are not like Hawaiʻi Island trails where they are paved. Kauaʻi trails tend to get overgrown and lost. I don't know of any trails. But undoubtedly they were there.*

C. Kupuna Elizabeth Kalehumakanoe Bukoski

Kupuna Elizabeth Kalehuamakanoe Bukoski was born on December 31, 1921 to Puaokina Taniguchi and Elizabeth Charmin Taniguchi in Waimea Valley on the island of Kauaʻi. Mrs. Bukoski came to live in Kōloa in the 1930s and went to live with her relatives, the Spencer Family. After graduation from high school she worked on the Kōloa Plantation owned by Alexander and Baldwin where she met her future husband. Mr. Frank Bukoski was a *luna* or overseer to the plantation workers. Later Mrs. Bukoski obtained interest in the Charmin Family lands and exchanged the lands for the eight acres on which she and her children live today. The eight acres are located on Hapa Road immediately west of the proposed project area. Today *kupuna* Elizabeth is very active in the Kūpuna Program in Kōloa.

Asked about the translation for Kōloa Mrs. Bukoski stated:

> *Kōloa's name derived from the cane they were hauling at that time in the early days during my grandfather's time. They had to come through Māhāʻulepū at that time. The cane was put in the cane carts and was pulled by horses and mules. The carts were pulled to the mill and then ground.*

Mrs. Bukoski recalls sending her children into the land across the road (the present project area) to gather native plants for medicine:

> *When my children were young I used to send them in the fields across the way* [pointing across Hapa Road into the project area] *to gather plants for medicine. When they were sick I had them gather the* ʻuhaloa*. They would bring the plant back home and I used to scrape it then remove the stem inside. If my children only had a sore throat I would have them chew on the leaves. Other than that I would boil it and make a tea out of it. I also sent them to gather in that same area the* pōpolo *that we used for the top of the head of a child to keep the* manawa *open. The longer you leave it open the better it is for the child. There was less chance for the child to get sick. In those days people believed, but if you tell people today about that practice they do not believe. Believe it or not your children did not get sick as much as other children. I used to pound the leaf. Along the old road* [now Hapa Road] *there were many different native trees like* koa *and the one that had a big seed and yellow flower called* kamane*. They were all later cleared out.*
>
> *I used* alae *with sea salt. It becomes medicine when you mix the* alae *with it. When a child has a cold instead of drinking plain water, you warm up the water and put the* alae *salt and then they drink it. I also would gather the* ʻopihi *down at Pōʻipu. I used to sell them to Honolulu. I was fortunate to pick* ʻopihi *from all the different places that I went. I kept a few shells and made pendants out of them. I would dive deep down in the ocean to get the big ones coming up for air and back down again, poke them until I got if off the rock. Today the* ʻopihi *is so scarce. The other traditional practice was down at the beach. We used to* hukilau *with Jim Kimokeo at that time. The* hukilau *was big in those days. Down at Pōʻipu we used to catch*

> ʻōʻio. *Those days people would rather have* ʻōʻio *rather than* akule. *The Japanese liked the ʻōʻio to make fish cake. I used to love that. My husband used to like it the Portuguese way. He would put them in vinegar and then fry them. Now days there are no more* hukilau *like we used to have. How sad.*
>
> *I raised my oldest* moʻopuna *the traditional Hawaiian style. The oldest grand daughter I took her for me. I just raised her like my own. She is here now from the mainland. I later legally adopted her. She is now going to build a house on the land behind us here.*

Mrs. Bukoski mentions that the first road dividing her family's land and the Knudsen Trust Lands was not paved:

> *The Pōʻipu Road used to be where Hapa Road is today.* [Hapa Road borders the present project area and Mrs. Bukoski's family residence.] *That is the first road they had and it was not paved. The County put in a dumping ground near where the St. Raphael Church is today. My husband later worked for the county and took care of the dumping grounds. Hapa Road was the only road in the early days. During the early Kōloa days we used to have an annual parade starting from Kōloa Town down to here using the old road. That was a big event in those days. Everyone would come together and cook different kinds of food. I do not recall any other trails in this area other than the old road.*

She recalls how the streams were the family's source of water and food:

> *There were streams that used to flow from Māulili Pond. The water came from Waita all over to Kōloa right by Sueoka Store which has the river over there the Waikomo Stream and used to come all the way down to Māulili Pond over here. We used to go fishing inside the stream. We fished for ʻ*akupa*, something like the* ʻoʻopu. *We used to call that adduce when we were kids.*

Mrs. Bukoski shared her concerns with about the proposed development:

> *My concern about the future plans of the project area is does the developer know this place here? Why put something inside of there when you do not really know what is in there and have not gone and seen themselves? The Hawaiian people will tell you that it is very* mahaʻoi. *If you do not know this ʻ*āina *do not go and* mahaʻoi *around that place. To me one will be punished by going over there and building when you do not know everything about that place. That is why I say, "If you do not know a person that well why should you do this and that for the person. You do not know that person's ways. This is going to be a major development. Why go into it without searching the area for things of the past that could be there but you do not know. I would not want such a development there across from where we live. It is so quiet and peaceful here, no one around but my family.*

D. Billy Kaohelauliʻi

Billie Kaohelauliʻi was born on July 4, 1950 to Henry Kalima Kaohelauliʻi from Niʻihau and his wife Hazel Tita Kimokeo. Mr. Kaohelauliʻi was raised in Kōloa where he presently resides. Mr. Kaohelaulii heads a native organization called "Hui Malama Kāne I Olo Uma". The group presently cares for the cultural sites bordered by Pōʻipu Road and the parking lot of Brenneke's

Restaurant at Pōʻipu Beach in Kōloa. Mr. Kaohelauliʻi currently works throughout the island of Kauaʻi setting up stage productions for various musical entertainers. Mr. Kaohelauliʻi graciously shared his knowledge in an interview with Cultural Surveys Hawaiʻi Inc. on January 5, 2005 at Pōʻipu Beach Park.

When asked if his family ever had any association with the project area Mr. Kaohelauliʻi mentioned:

> *We used to just go up there and sit in peace and talk with the spirits. Ella, my eldest sister, walked to church every Sunday on the trail that borders the project area and gathered seeds to make lei and fruit to eat. In the proposed project area was a* heiau. *When we were young, we used to pick mangos to eat. We also gathered* ʻilima *flowers for making leis and gathered wood for* imu *in the project area.*

Mr. Kaʻohelauliʻi recalled there was a trail by the church to go to Kōloa Town:

> *We had no name for the trail, but it would take us from the beach all the way up to the church and then to Kōloa Town. The trail was lined with rocks about knee high. From about 1958 on I used to ride my bike on a trail that led* mauka *from the beach park. There are trails all through the area they plan to develop.*

Mr. Kaohelauliʻi described the cultural sites and burials he has seen with in the project area:

> *The cultural sites within the project area, now the Knudsen Trust Lands, was part of an ancient Hawaiian complex including* heiau *and native habitats. The project area has many ancient house foundations, birth places, caves and rock walls all over. There are remnants in areas once used to plant taro and sweet potato.*
>
> *There are burials* [adjacent to the project area] *directly above the Kiahuna Shopping Village* [pointing to a parcel just west of the project area on a map].
>
> *At one time before the county road was put in* [Pōʻipu Road] *the cultural sites in the Knudsen lands were connected to the cultural sites which our group is presently caring for*
>
> *The land which we are caring for was once used for arm wrestling, sports,* makahiki *ceremonies and games.*

Asked if he has any concerns about the proposed development of the project area Mr. Kaohelaulii mentioned:

> *While many of the land titles remain unclear the* kanaka *culture is being removed off their* ʻāina*. Intentional destruction and degradation of ancient and historical sites, watershed contamination, the paving of wetlands is destroying our culture, as well as our unique reef ecosystem. Migratory birds stop here from Alaska. Preservation is essential for the culture to exist. Other concerns are over-population of already crowded beaches and facilities. Trash and what to do with it is an overwhelming concern.*

E. David Chang

David Chang was born in Waimea on the island of Kauaʻi and raised in Kōloa where he resides today. He is a local historian of Kōloa. Mr. Chang participated in a telephone interview with Cultural Surveys Hawaiʻi Inc. on March 18, 2005.

Mr. Chang shared his concerns about the habitat of the blind spider and caves, which are the habitat of the anthropoids or blind shrimp:

> *My main concern is the critical habitat of the blind spider and the caves which contain the anthropoids or blind shrimp. They will most likely find caves within the proposed project area containing these creatures which must be preserved. The only known habitat for two of Kauai's strangest endangered animals recently received critical habitat designation from the U.S. Fish and Wildlife Service. The eyeless wolf spider and one of its preys, a shrimp-like eyeless amphipod, both live deep inside the dark, damp caves of Kauai's Koloa District, and nowhere else in the world. There are perhaps fewer than 30 Kaua'i cave spiders in existence, all living in a single cave. The cave amphipod, also blind, is regularly found in three caves, including the one where the cave wolf spider is found.*

IX. TRADITIONAL CULTURAL LANDSCAPE OF KŌLOA AHUPUAʻA AND THE PROJECT AREA

Late eighteenth-century accounts by European navigators record well-maintained agricultural systems above the southern coast of Kauaʻi. The evidence suggests that, by the beginnings of western contact, the Hawaiian inhabitants of Kōloa were well-versed in the agricultural arts, maintaining fields that included taro, sugarcane, and sweet potatoes. The extensive agricultural systems of the region would have supported a substantial population. Even in 1833, following the depredations of diseases and social disruption introduced by decades of western contact, the population of the Kōloa district (from Wahiawa to Kalapaki) was 2,166.

Fourteen *heiau* in Kōloa were documented in an early oral history project of the 1880s. The variety of class and function – including *luakini* and *poʻokanaka* class *heiau*, and *heiau* related to fishing, medicine, and agriculture – illustrate the range of the traditional Hawaiian belief system established in Kōloa.

Discussions of specific aspects of traditional Hawaiian culture as they may relate to the project area are presented below. The concluding discussion examines resources and practices identified within the project area in the broader context of the encompassing Kōloa Ahupuaʻa landscape.

A. Hawaiian Habitation and Agriculture

Based on archaeological studies and historical accounts, habitation and intensive irrigated agriculture were widespread in central and coastal Kōloa utilizing the opportunity to develop an extensive irrigated complex – the Kōloa Field System – off of Waikomo Stream.

The present project area was a *portion* of the pre-contact Kōloa Field System. As noted in the documentation of three Land Commission Awards (LCAs) – 3610 and 3409 – (see Section III E above) agricultural growing areas, including *loʻi* were present within the project area in the mid-nineteenth century. Also identified in the LCA documents were a house site and pasture land.

It is likely that the habitation and agricultural activity recorded in the documents reflect the continuation into the nineteenth century of the primary traditional Hawaiian land use and cultural activity within the project area and vicinity.

However, subsequent nineteenth and early twentieth century land modification associated cattle ranching and, to a lesser extent, with sugar cane cultivation in the project area have severely compromised the formal integrity of surface sitesʻ and features associated with traditional Hawaiian life.

The presence of habitation sites and agricultural features within the project area is confirmed in the interviews with community informants Chris Kauwe and Billy Kaohelauliʻi. Mr. Kauwe reports seeing within the project area "remnants of rock walls, platforms, rock-floored house sites, c-shaped rock formations, and standing mounds which indicate obvious signs of *kanaka* habitation." Mr. Kaohelauliʻi has seen in the project area "many ancient house foundations, birth places, caves and rock walls all over...There are remnants in areas once used to plant taro and sweet potato."

Both Mr. Kauwe and Mr. Kaohelauli‘i stress that, during traditional Hawaiian times, the present project area was continuous with the *makai* lands now separated by Pō‘ipu Road. Hawaiian activities – habitation, agricultural, social, and religious – would have been integrated in the now-separated areas.

B. Gathering for Plant Resources

No specific native Hawaiian gathering practices for plant resources were identified within the project area in the historical documentation and archaeological investigations. However, community informants interviewed for this cultural impact assessment (see Section VIII) describe ongoing native gathering practices within the project area.

Mr. Chris Kauwe mentioned that many of the native herbs he uses in his practice of *lapa‘au* (healing), such as *popolo*, *kinihe*, and *‘ilima*, are still collected from within the project area.

Kupuna Elizabeth Kalehuamakanoe Bukoski discussed sending her children into the project area to gather native plants for medicine. A few of the plants she listed were *‘uhaloa* (the stem and leaves used to treat illnesses such as sore throat) and *pōpolo* (the leaves were used to keep the *manawa* on top of a child’s head open).

Mr. Billy Kaoheluli‘i mentioned that while growing up, his family gathered seeds and *‘ilima* to make *lei* and wood for *imu* in the project area.

C. Aquatic Resources

Native stream animals supplied the Hawaiian diet with a rich source of protein. Waikomo Stream, to the west of the project area, would have given Hawaiian inhabitants of the project area and vicinity access to native fish, shrimp, and mollusks including: ‘*o‘opu, ‘ōpae,* and *hihiwai*. Within the project area itself, no aquatic resources are available.

As a side note, Mrs. Elizabeth Bukoski mentioned a stream that once flowed from Māulili Pond. She recalls the water flowed from Waita thru Kōloa Town to Maulili Pond. Mrs. Bukoski used to go fishing in the streams of Maulili Pond and catch *`akupa*, something like the *‘o‘opu* fish.

D. Traditional Hawaiian Sites

Previous archaeological research in and surrounding the present project area has documented material finds indicative of an extensive system of agricultural fields as well as temporary and permanent habitation (see Section V B, “Summary of Previous Archaeology Specific to Current Project Area”).

In addition, as noted above, community informants Mr. Chris Kauwe and Mr. Billy Kaohelauli‘i have described observing habitation and agricultural sites within the project area.

Mr. Reginald Gage expressed concern that although extensive historic ranching in the area has likely destroyed many traditional Hawaiian sites, because the area is very rocky and inhospitable to historic urbanization, sites (as well as trails or burials) may still remain hidden within the present project area.

E. Burials

One of the community informants interviewed for this cultural impact assessment (see Section VIII), Mr. Kaohelauli‘i, mentioned that he believes there are burials located near the top of the project area directly above the Kiahuna Shopping Village. However, Mr. Reginald Gage mentions that he knows a great deal about the caves in Kōloa because of his work with Stores Olsen, a curator of birds at the Smithsonian Museum. Together they have searched the caves in Kōloa for bird remains. As Mr. Gage looks back at those times he cannot recall ever have seen any burials in Kōloa caves.

F. Native Hawaiian Hunting Practices

No specific native Hawaiian hunting practices were identified within the project area in the historic documentation, archaeological investigations, or community informants.

Game animals hunted on Kauaʻi include pigs, goats, black-tailed deer and a variety of game birds. Black-tailed deer were introduced in 1961 and are not found near the project area. The vicinity of the project area is not shown to have either concentrated or sparse densities of either pigs or goats on species range maps (Van Riper and Van Riper III 1982: 25, 34). Historically, game bird hunting introduced pheasants and chukars on the sporadic pasture lands within the present project area.

G. Hawaiian Trails

Trails served to connect the various settlements throughout the *ahupuaʻa* and districts of the Hawaiian Islands in traditional times. Based on testimonies in the Land Commission Award documents, the alignment of the present Hapa Road along the west boundary of the project area may follow the path of a traditional trail. *Kupuna* Elizabeth Bukoski mentions that Hapa Road was formerly the main access route from Kōloa Town to coastal Pōʻipu. This was the first road they had in the area and it was not paved.

Mr. Chris Kauwe, described foot-trails from the sub-division of Weliweli Tract that lead to the present project area. He mentioned that in the summer of 1996 he spent many weekends mapping the area and along with the trails, noted the remains of preserved traditional Hawaiian habitation sites in the area.

H. *Wahi pana* (Storied Places)

While areas – such as Maulili Pond – of Waikomo Stream, which runs to the west of the project area, were *wahi pana* associated with Hawaiian traditions, no other storied places were identified in the immediate vicinity of the project area.

I. The Project Area within the Kōloa Ahupuaʻa Context

Kōloa Ahupuaʻa follows the typical *ahupuaʻa* pattern, extending *mauka* from the coast to the upland forest areas. Within the *ahupuaʻa* can be found a wide variety of cultural practices and resources, depending on location within this broad *makai* to *mauka* context. One agricultural practice that has been well documented for Kōloa is taro cultivation extending inland along existing streams and their tributaries. Forest areas miles inland would have been utilized for a variety of purposes, especially gathering of timber, avian resources, medicinal plants, and famine food resources. Presently the *mauka* portions of Kōloa Ahupuaʻa are in the forest reserve. It is probable that botanical resources traditionally used in Hawaiian culture still exist in these forest areas that, unlike the present project area, were never subject to commercial agriculture. In the *makai* areas of Kōloa Ahupuaʻa, fishing and marine resource gathering practices continue to occur along the coast areas, as have been documented in the past.

The habitation and agricultural activities – documented by Land Commission Award records – within the present project area identify it as the land base of a Hawaiian community sustained by the extensive agricultural field system that stretched across the central Kōloa landscape.

X. SUMMARY

Reviewing the information provided by the elements of this cultural impact assessment – historical documentation, archaeological research, and community contacts and interviews – there emerges a more detailed picture of the traditional landscape of Kōloa Ahupuaʻa and the present project area. By the end of the eighteenth century, the project area comprised a portion of an intricate network of taro *loʻi, ʻauwai,* and associated habitation sites that stretched across the *makai* floor of Kōloa Ahupuaʻa. This network, identified by Cultural Surveys Hawaiʻi as the Kōloa Field System, incorporated unique engineering innovations that allowed otherwise inhospitable lands – at a distance from water sources – to sustain a growing population.

Nineteenth-century documents indicate that remnants of the traditional Hawaiian settlement pattern survived the first seven decades of western contact. Records of the mid-nineteenth century Mahele provide the first specific documentation of traditional Hawaiian activities, practices and land use within the project area. The Mahele documents reveal that, within and around the current project area, land usage and activity by the mid-nineteenth century included habitation and taro cultivation. This may reflect the continuation into that century of traditional Hawaiian land use within the project area.

The Knudsen family entered the Kōloa historical record in 1870 when Eliza Sinclair bought most of Kōloa Ahupuaʻa and gave the land to her daughter Anne upon Anne's marriage to Valdemar Knudsen. The Knudsen lands of Kōloa were subsequently managed by trusts formed by the descendants of Valdemar and Anne. The current project area is a portion of the Eric A. Knudsen Trust.

Historic documentation of Kōloa from the last decades of the nineteenth century suggest that taro *loʻi* continued in existence in the 1880s with the population dispersed across the Kōloa plain— *loʻi* and house sites were present within the current project area.

By the first decades of the twentieth century, cane fields of the Kōloa Sugar Company and McBryde Sugar Company spanned the landscape of Kōloa. However, sugar company field maps from the early 1900s indicate only small incursions of sugarcane within the project area.

Further documentation suggests that, by the 1930s, the taro *loʻi* and house sites that characterized the Kōloa landscape in the 1880s were no longer in use. By the mid-twentieth century, the project area comprised areas of open pasture, with sugar cane extending into small portions. At the end of the twentieth century, the project area continued to comprise open and brush-covered pasture land with now-discontinued sugar cane fields also present.

Archaeological studies have documented multiple historic properties associated with traditional Hawaiian habitation, agriculture, and cultural practices throughout the breadth of the project area.

Interviews were conducted with five members of the Kōloa community. Two interviewees noted that they continue to use the project area for the traditional cultural practices of gathering *lāpaʻau* for healing, *pule* or prayer and meditation. Three interviewees expressed concerns about Native Hawaiian cultural sites within the project area.

Also expressed were concerns over possible burial sites within the project area and the impact of future development on the local Kōloa lifestyle. Other impacts include increased population, water runoff polluting the fishing and surfing grounds *makai* of the project area, and loss of open quiet space.

Two members of Hui Mālama Kāne I Olo Uma stressed that, during traditional Hawaiian times, the present project area was continuous with the *makai* lands (which their organization is caring for) now separated by Pōʻipu Road. Hawaiian activities – habitation, agricultural, social, and religious – would have been integrated in the now-separated areas.

An ancillary concern expressed by one interviewee, Mr. David Chang, is the habitat of the blind spider. Mr. Chang suggests that caves within the project area may contain this and other endangered species.

XI. RECOMMENDATIONS

The following recommendations are suggested to mitigate concerns related to native Hawaiian cultural resources, beliefs and practices identified during the preparation of this assessment.

There is a concern over the possibility that burial sites – both surface and subterranean – are present and may be encountered during future development activities within the project area. Regarding the discovery of burials, state law (Chapter 6E, Hawai`i Revised Statutes) requires the following:

1. Stop all disturbing activity in the immediate area.
2. Leave all remains in place.
3. Immediately notify the Department of Land and Natural Resources/State Historic Preservation Division (DLNR/SHPD) and the county police department.

Further procedures are in place to ensure that proper treatment of any burial finds is coordinated with appropriate agencies, including the DLNR/SHPD and the Kaua`i/Ni`ihau Islands Burial Council.

A specific concern mentioned by community members interviewed is the presence of traditional Hawaiian historic properties – including archaeological sites and cultural deposits. A component of the archaeological investigations already undertaken within the project area has been the formulation of preservation procedures for significant historic properties recorded during these investigations. It is recommended that these procedures be implemented – prior to and during future development – to ensure the protection and preservation of all religious and burial sites (if present), and of examples of habitation and agricultural sites in the area. It is further recommended that, in the event that previously unrecorded, significant historic properties are encountered during the course of development activities, further preservation measures should be undertaken for these properties' protection.

Community interviewees have mentioned that the project area has been, and continues to be, accessed for gathering of native Hawaiian plants for traditional practices of *lāʻau lapaʻau* and *pule*, and meditation. In order to mitigate the impact of future development upon traditional gathering practices, it is recommended that native Hawaiian plants be incorporated in the landscaping in and around archaeological preserve area(s) of the project area. Access to these areas for gathering purposes can be coordinated with members of the local community.

Future development of the project area can have minimal impact upon native Hawaiian cultural resources, beliefs and practices, provided that measures for preservation of historic properties and burial treatment are implemented, and there is proper treatment of any previously unrecorded, significant historic properties which may be encountered during development (including consultation with the State Historic Preservation Division and, as may be appropriate, with Kauaʻi community cultural organizations).

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Appendix L

TRAFFIC IMPACT ANALYSIS REPORT
VILLAGE AT POIPU
2005 UPDATE
POIPU, KAUAI, HAWAII

FINAL

September 13, 2005

Prepared for:

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TRAFFIC IMPACT ANALYSIS REPORT
VILLAGE AT POIPU
2005 UPDATE

Poipu, Kauai, Hawaii

FINAL

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September 13, 2005

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AUSTIN, TSUTSUMI & ASSOCIATES, INC. CIVIL ENGINEERS • SURVEYORS
CONTINUING THE ENGINEERING PRACTICE FOUNDED BY H. A. R. AUSTIN IN 1934

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TRAFFIC IMPACT ANALYSIS REPORT
VILLAGE AT POIPU
2005 UPDATE
Poipu, Kauai, Hawaii

I. INTRODUCTION

The Traffic Impact Analysis Report for the Village at Poipu, dated December 8, 2003, prepared by Austin, Tsutsumi & Associates, Inc. ("ATA"), documents the findings of a traffic study to evaluate the potential traffic impacts resulting from the Village at Poipu development (hereinafter referred to as the "Project"). This report is an update of the December 2003 report and reflects the current development plans for the Project.

A. Location

The Eric A. Knudsen Trust (the "Developer") proposes to develop the Village at Poipu on approximately 210 acres on the southern coast of the Island of Kauai east of the existing Poipu Resort area. The Project site is more specifically identified as TMKs: 2-8-013:001 and 2-8-014:001, 002, 003, 004, 019, and 037. Figure 1 shows the location of the proposed Project.

B. Project Description

The Project site was once envisioned as a golf course with a mixture of discontinuous residentially zoned areas. The concept has been re-evaluated, and a new master plan has been prepared for the Project site. The new master plan consists of approximately 350 to 503 multi-family and single-family homes, archaeological preserves and community parks. The Project is envisioned as a bike and pedestrian-friendly community interlaced with landscaped pathways to provide residents the ability to travel easily between mauka and makai areas of the Project, walking or bicycling to Poipu Beach or other amenities such as the

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Kiahuna Tennis and Swim Club. The owners of these homes are envisioned to be a mixture of local residents and part-time residents.

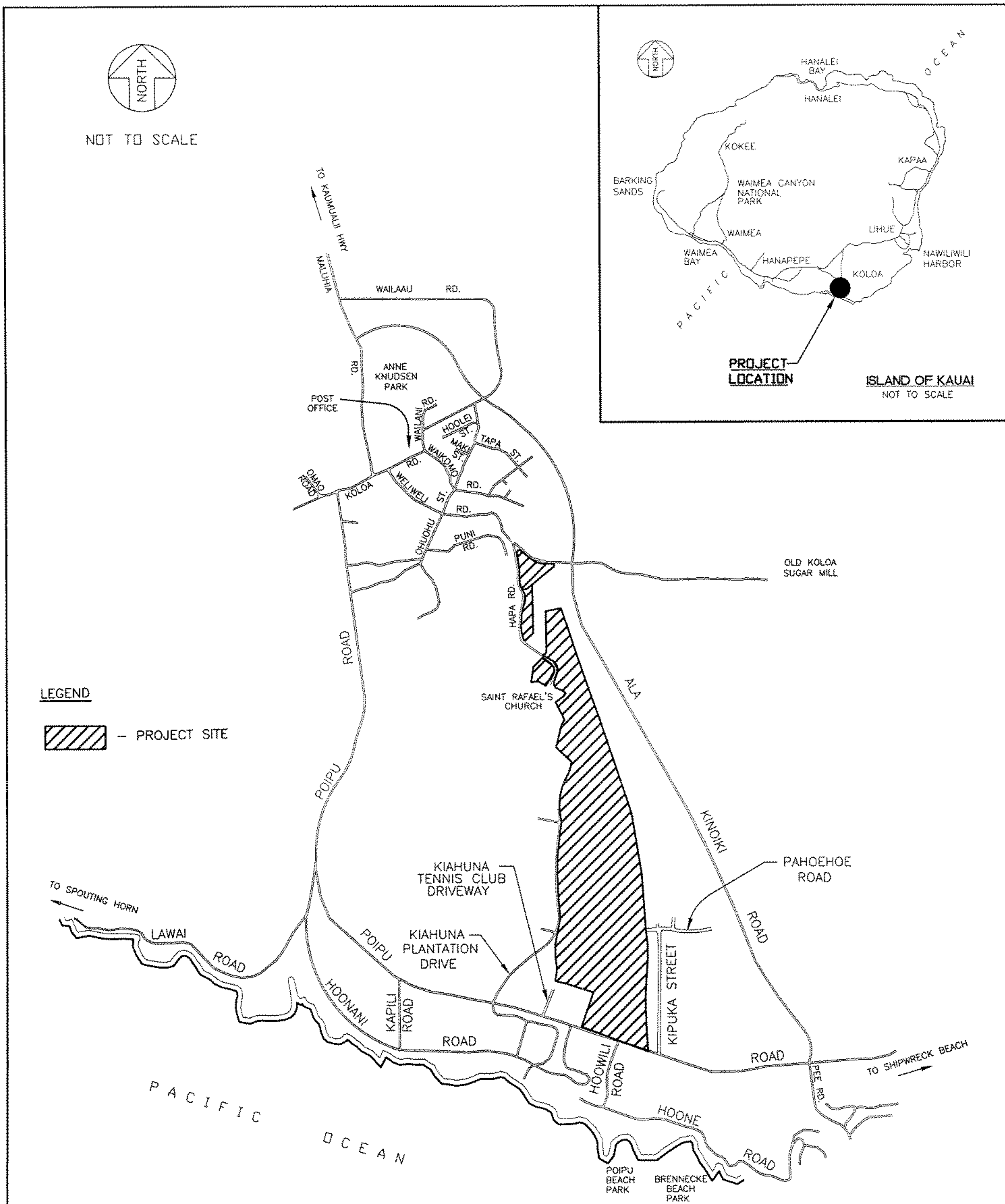
The Project will be developed in three (3) phases. Phase 1 is expected to be under construction shortly. Therefore, Year 2006 was chosen for the anticipated completion of Phase 1. Phase 2 and Phase 3 are anticipated to be completed by Year 2010 and Year 2015, respectively. Table 1 shows the proposed development schedule utilized for the traffic study. Owners of some single-family lots will have the option to construct dwelling units within their lot. These additional dwelling units (ADUs) are included in the unit counts, shown in Table 1, as a conservative measure. The unit counts shown in Table 1 would be reduced by 153 single-family units if none of the ADUs are constructed. Figure 2 shows the preliminary site plan for the proposed Project.

Table 1
Village at Poipu Land Use

	Phase 1 Year 2006	Phase 2 Year 2010	Phase 3 Year 2015	Total
Single-Family (dwelling units)	25	44	116	185
Multi-Family (dwelling units)	--	67	--	67
Recreational Homes (dwelling units)	25	110	116	251
Community Park (acres)	2.5	6.0	3.5	12.0
			Approximate Total Units	503

The Project is proposed to have five (5) access points onto the existing roadway network. The following are the locations of the access points:

- Through the existing Kiahuna Plantation Drive
- Through the existing Kiahuna Tennis Club Driveway
- Through construction of a new road (Driveway A) intersecting Poipu Road at its intersection with Hoowili Road
- Through the existing northern portion of Hapa Road
- Through the existing Kipuka Street via an extension of the existing Pahoehoe Street

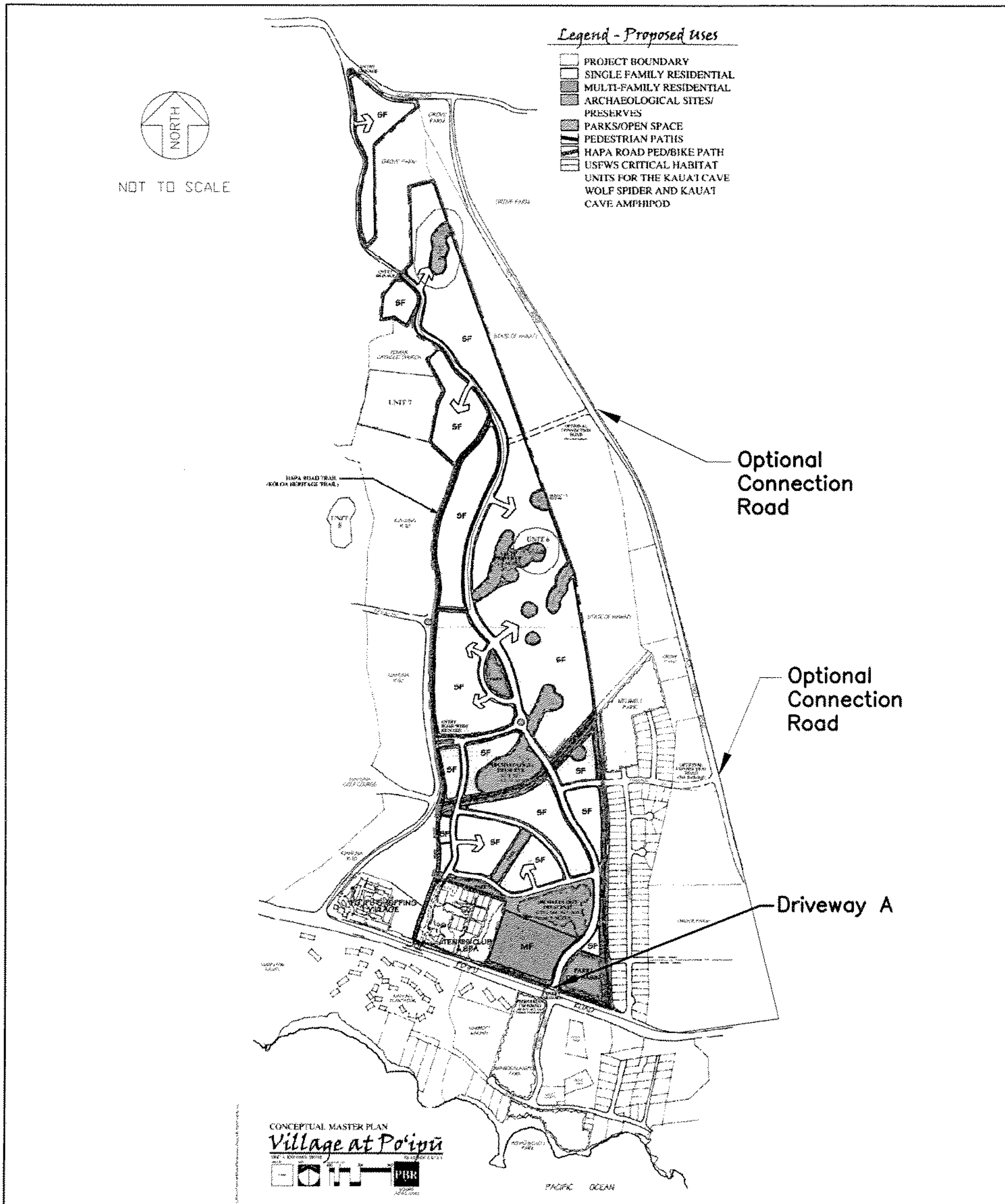


ERIC KNUDSEN TRUST
VILLAGE AT POIPU
2005 UPDATE

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS, SURVEYORS • HONOLULU, HAWAII

PROJECT LOCATION

FIGURE 1



ERIC KNUDSEN TRUST VILLAGE AT POIPU 2005 UPDATE	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS, SURVEYORS • HONOLULU, HAWAII	FIGURE
	PRELIMINARY SITE PLAN	2

There are two (2) optional connector roads between Ala Kinoiki Road and the Project. However, land acquisition issues would need to be resolved between the developer and adjoining landowners. Since a timetable for the construction of the two (2) optional project access roads are unknown at this time, access on Ala Kinoiki Road will not be considered in this traffic study and therefore, assumes the "worse-case" scenario, with five (5) access points instead of seven (7).

C. Study Methodology

The study will address the following.

1. Existing traffic operating conditions at the key intersections within the study area.
2. Base Year traffic projections without Project-generated traffic for each of the three build-out years of the proposed Project.
3. Trip generation and traffic assignment characteristics for the proposed Project.
4. Determination of the potential impact of project-generated traffic on the base year(s) traffic operation for each phase of development.
5. Recommendations of mitigation measures, as appropriate, to reduce or eliminate adverse impacts resulting from traffic generated by the proposed Project.

II. EXISTING CONDITIONS

The Project is proposed to be developed on approximately 210 acres of vacant land bordered by Weliweli Road and Hapa Road to the north, Poipu Road to the south, and Kiahuna Plantation Drive to the west.

A. Roadway System

The following are brief descriptions of the existing roadway network within the study area.

Maluhia Road is a two-way, two-lane, County collector roadway that is oriented in the north-south direction from Kaumualii Highway to

Koloa Road. The posted speed limit on Maluhia Road varies from 35 to 50 miles per hour (mph) and is reduced to 25 mph as the road approaches Koloa Town.

Ala Kinoiki Road, also referred to as the (Koloa/Poipu) Eastern Bypass Road, is a two-way, two-lane, County arterial roadway that is oriented in the north-south direction, providing an alternate route from Maluhia Road in Koloa to Poipu. Ala Kinoiki Road intersects Maluhia Road north of Koloa Town and continues to Poipu, intersecting Poipu Road directly across Pee Road on the east side of Poipu. The posted speed limit on Ala Kinoiki Road is generally 40 mph, with reduced speeds approaching each terminus. Approaching the southern terminus at Poipu Road, the speed is reduced to 35 mph; approaching the northern terminus at Maluhia Road, the posted speed limit is reduced to 25 mph.

Koloa Road is a two-way, two-lane, County collector roadway that is oriented in the east-west direction from Kaumualii Highway in Lawai to Waikomo Road in Koloa. The posted speed limit on Koloa Road varies between 50 mph and 25 mph on the section of Koloa Road from Kaumualii Highway to Poipu Road. The speed limit varies between 15 and 25 mph in Koloa Town.

Poipu Road is a two-way, two-lane, County collector roadway that is oriented in the north-south direction from Koloa Road to Lawai Road. Poipu Road changes direction after its intersection with Lawai Road and is oriented in the east-west direction east of Lawai Road. The posted speed limit on Poipu Road is 25 mph.

Weliweli Road is a two-way, two-lane, County roadway that is oriented in the east-west direction from Koloa Road to the Old Koloa Sugar Mill. Weliweli Road intersects Ala Kinoiki Road east of Koloa Town. The posted speed limit on Weliweli Road is 25 mph.

Hapa Road is a two-way County roadway that is oriented in the north-south direction, which begins as the stem of a "Tee"-intersection with Weliweli Road and terminates at Saint Rafael's Church. Hapa Road serves local residences and Saint Rafael's Church in the northern portion of the Project.

Kiahuna Plantation Drive is a two-way, two-lane, private driveway that is oriented in the north-south direction that begins at its intersection with Poipu Road to the south. Kiahuna Plantation Drive provides access to Kiahuna Golf Club, Poipu Shopping Village, and the Kiahuna Golf Village residences. The posted speed limit on Kiahuna Plantation Drive is 25 mph.

Kiahuna Tennis Club Driveway is a two-way, two-lane, private roadway that is oriented in the north-south direction which begins as the stem of a "Tee"-intersection with Poipu Road. The Kiahuna Tennis Club Driveway serves as the only access to the Kiahuna Tennis Club.

Hoowili Road is a two-way, two-lane, County roadway that is oriented in the north-south direction providing vehicular circulation between Poipu Road and Hoone Road. Hoowili Road provides access to Poipu Beach Park, Brennecke Beach Park, and single-family residences. The posted speed limit on Hoowili Road is 25 mph.

Kipuka Street is a two-way, two-lane, County roadway that is oriented in the north-south direction which begins as the stem of a "Tee"-intersection with Poipu Road and terminates at its intersection with Pahoehoe Road to the north. Kipuka Street serves the Weliweli Tract single-family residences. The posted speed limit on Kipuka Road is 25 mph.

Pahoehoe Road is a two-way, two-lane, County roadway that is oriented in the east-west direction and is located in the northern portion of the Weliweli Tract single-family residences.

Pee Road is a two-way, two-lane. County roadway that is oriented in the north-south direction. Pee Road intersects Poipu Road directly across Ala Kinoiki Road and terminates at its intersection with Hoone Road to the south. Pee Road serves the residences and resorts around the Poipu Crater Resort area. The posted speed on Pee Road is 25 mph.

B. Study Intersections

Manual turning movement traffic counts were conducted at the following unsignalized study intersections on Tuesday, June 3, 2003, through Thursday, June 5, 2003, and on Thursday, August 21, 2003.

- Maluhia Road/Ala Kinoiki Road
- Koloa Road/Maluhia Road
- Koloa Road/Poipu Road
- Koloa Road/Weliweli Road
- Weliweli Road/Hapa Road
- Weliweli Road/Ala Kinoiki Road
- Poipu Road/Ala Kinoiki Road/Pee Road
- Poipu Road/Kiahuna Tennis Club Driveway
- Poipu Road/Kiahuna Plantation Drive
- Poipu Road/Hoowili Road
- Poipu Road/Kipuka Road

Based on the traffic count data collected at the study intersections, it was determined that the weekday AM peak hour of traffic occurs from 7:15 AM to 8:15 AM and the weekday PM peak hour of traffic occurs from 3:45 PM to 4:45 PM. The turning movement count data is included as Appendix A.

The study intersections are briefly described below. Figure 3 shows the existing lane configurations at these intersections.

<u>Maluhia Road/Ala Kinoiki Road</u>

Ala Kinoiki Road forms the stem of an unsignalized "Tee"-intersection with Maluhia Road. The Ala Kinoiki Road westbound approach is stop-sign-controlled and has an exclusive left-turn lane and an exclusive right-turn lane. The Ala Kinoiki Road westbound right-turn lane connects to an exclusive northbound acceleration lane on Maluhia Road, forming a "free" right-turn. The Maluhia Road northbound approach has a through lane and an exclusive right-turn lane. The Maluhia Road southbound approach has a through lane and an exclusive left-turn lane.

Koloa Road/Maluhia Road

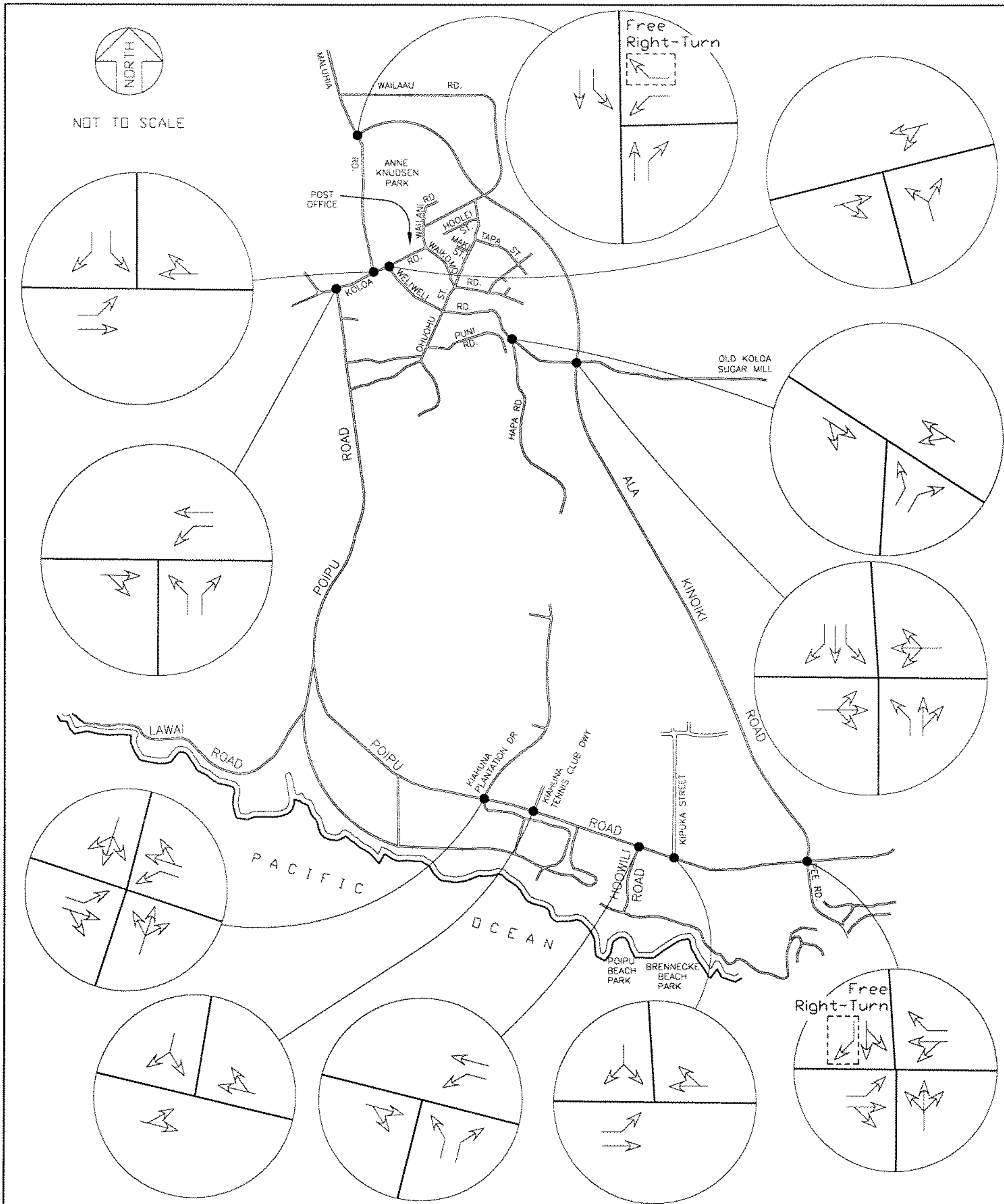
Maluhia Road forms the stem of an unsignalized "Tee"-intersection with Koloa Road. The Maluhia Road southbound approach has an exclusive right-turn lane and an exclusive left-turn lane. The Maluhia Road southbound right-turn traffic is yield-sign-controlled, while the Maluhia Road southbound left-turn traffic is stop-sign-controlled. The Koloa Road eastbound approach has an exclusive left-turn lane with a storage length for approximately six (6) to seven (7) vehicles and a through lane. The Koloa Road westbound approach has a single shared lane for through and right-turn traffic movements.

Koloa Road/Poipu Road

Poipu Road forms the stem of an unsignalized "Tee"-intersection with Koloa Road. The Poipu Road northbound approach has an exclusive right-turn lane and an exclusive left-turn lane. The Poipu Road northbound exclusive right-turn traffic is yield-sign-controlled, while the northbound Poipu Road exclusive left-turn traffic is stop-sign-controlled. The Koloa Road westbound approach has an exclusive left-turn lane with a storage length for approximately seven (7) to eight (8) vehicles and a separate through lane. The Koloa Road eastbound approach has a single shared lane for through and right-turn traffic movements.

Koloa Road/Weliweli Road

Weliweli Road forms the stem of an unsignalized "Tee"-intersection with Koloa Road. The Weliweli Road northbound is stop-sign-controlled and has a single shared left-turn/right-turn lane. The Koloa Road eastbound approach has a single shared lane for through and right-turn traffic movements while the westbound Koloa Road approach has a single shared lane for left-turn and through movements.



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EXISTNG LANE CONFIGURATION

FIGURE 3

Weliweli Road/Hapa Road

Hapa Road forms the stem of an unsignalized "Tee"-intersection with Weliweli Road. The Hapa Road northbound approach is stop-sign-controlled and has an exclusive right-turn and an exclusive left-turn lane. The Weliweli Road westbound approach has a single lane for left-turn and through movements. The Weliweli Road eastbound approach has a single shared lane for through and right-turn movements.

Weliweli Road/Ala Kinoiki Road

Weliweli Road forms a cross-intersection with Ala Kinoiki Road. The stop-sign controlled Weliweli Road westbound and eastbound approaches have a single shared lane for left-turn, through and right-turn movements. The Ala Kinoiki Road northbound approach has an exclusive left-turn lane with a two (2) to three (3) vehicle storage length and a shared right-turn/through lane. The Ala Kinoiki Road southbound approach has an exclusive left-turn lane with a two (2) to three (3) vehicle storage length, a through lane, and an exclusive right-turn lane.

Poipu Road/Ala Kinoiki Road/Pee Road

Ala Kinoiki Road is the north leg and Pee Road is the south leg of a cross-intersection with Poipu Road. The stop-sign-controlled Pee Road northbound approach has a single shared lane for left-turn, through and right-turn movements. The Ala Kinoiki Road southbound approach has an exclusive right-turn lane connecting to an acceleration lane on westbound Poipu Road forming a "free" right-turn. A stop-sign-controlled southbound shared through/left-turn lane is provided on Ala Kinoiki Road. The Poipu Road eastbound approach has an exclusive left-turn lane and a shared right-turn/through lane. The Poipu Road westbound approach has a shared left-turn/through lane and an exclusive right-turn lane.

Poipu Road/Kiahuna Tennis Club Driveway

Kiahuna Tennis Club Driveway forms the stem of an unsignalized "Tee"-intersection with Poipu Road. The stop-sign-controlled Kiahuna southbound Tennis Club Driveway has a shared right-turn and left-turn lane. The Poipu Road eastbound approach has a shared right-turn/through lane. The Poipu Road westbound has a shared through/left-turn lane.

Poipu Road/Kiahuna Plantation Drive

Kiahuna Plantation Drive forms a cross-intersection with Poipu Road. The stop-sign-controlled Kiahuna Plantation Drive northbound and southbound approaches have single shared lane for right-turn/through/left-turn movements. The Poipu Road eastbound and westbound approaches have an exclusive left-turn lane and a shared right-turn/through lane.

Poipu Road/Hoowili Road

Hoowili Road forms the stem of an unsignalized "Tee"-intersection with Poipu Road. The stop-sign-controlled Hoowili Road northbound approach has an exclusive right-turn lane and an exclusive left-turn lane. The Poipu Road eastbound approach has a shared right-turn/through lane. The Poipu Road westbound approach has an exclusive left-turn lane and a through lane.

Poipu Road/Kipuka Road

Kipuka Road forms the stem of an unsignalized "Tee"-intersection with Poipu Road. The stop-sign-controlled Kipuka Road southbound approach has a single lane for right-turn and left-turn movements. The Poipu Road westbound approach has a shared right-turn/through lane. The Poipu Road eastbound approach has an exclusive left-turn lane and a through lane.

C. Field Observations

The Koloa Road/Poipu Road intersection operates with limited queuing of traffic with the longest queues observed to be approximately three (3) to four (4) vehicles for the northbound Poipu Road left-turn movement during the AM peak hour of traffic. Queuing was observed to be more prominent during the PM peak hour of traffic, with an approximate queue length of five (5) to ten (10) vehicles.

The Koloa Road/Maluhia Road intersection operates with limited queuing of traffic as the longest queues were observed to be approximately four (4) to five (5) vehicles for the Maluhia Road southbound left-turn movement and the Koloa Road eastbound left-turn movement during the AM peak hour of traffic. Queuing for the Maluhia Road southbound left-turn movement and the Koloa Road eastbound left-turn movement was also observed to be more prominent during the PM peak hour of traffic, with an approximate queue length of five (5) to ten (10) vehicles.

Diagonal parking is permitted along the south side of Koloa Road between Maluhia Road and Weliweli Road. It was observed that these parking maneuvers did not adversely impact traffic flow on Koloa Road. It was also observed that drivers use the unimproved shoulder along the north side of Koloa Road as diagonal parking stalls between Maluhia Road and Weliweli Road.

Queues of seven (7) to eight (8) vehicles on the southbound Ala Kinoiki Road approach and northbound Pee Road approach at its intersection with Poipu Road were observed. Queuing was also observed to be more prominent during the PM peak hour of traffic at the Ala Kinoiki/Poipu Road/Pee Road intersection.

D. Existing Traffic Condition Analyses

Level of Service (LOS) is a qualitative measure used to describe the conditions of traffic flow ranging from free-flow conditions, LOS A, to congested conditions, LOS F. The 2000 Highway Capacity Manual (HCM 2000) methods for calculating volume-to-capacity (v/c) ratios, delays and corresponding levels of service were utilized in this study. LOS Definitions for signalized and unsignalized intersections are provided in Appendix B. It should be noted that overall unsignalized intersection LOS is no longer calculated in the HCM 2000 procedure; LOS is only calculated for the stop-sign-controlled (minor) approaches and for left-turns from the major roadway.

Table 2 summarizes the LOS for the existing traffic conditions within the study area.

Maluhia Road/Ala Kinoiki Road

The Maluhia Road southbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic. The Ala Kinoiki Road westbound left-turn traffic operates at LOS A during the AM peak hour of traffic and at LOS C during the PM peak hour of traffic. The Ala Kinoiki

Road westbound right-turn traffic operates at LOS A during the AM peak hour of traffic and LOS B during the PM peak hour of traffic.

Koloa Road/Maluhia Road

The Maluhia Road southbound right-turn traffic operates at LOS A during the AM peak hour of traffic and at LOS B during the PM peak hour of traffic. The Maluhia Road southbound left-turn traffic operates at LOS B during the AM peak hour of traffic and at LOS E during the PM peak hour of traffic. The Koloa Road eastbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic.

The existing traffic volumes at this intersection are not likely to meet the Manual on Uniform Traffic Control Devices, (MUTCD) traffic signal warrants. Southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Koloa Road/Poipu Road

The Poipu Road northbound right-turn traffic operates at LOS B during the AM and PM peak hours of traffic. The Poipu Road northbound left-turn traffic operates at LOS C during the AM peak hour of traffic and at LOS F during the PM peak hour of traffic. The Poipu Road northbound left-turn traffic will be operating at overcapacity conditions during the PM peak hour of traffic. The Koloa Road westbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic.

The existing traffic volumes at this intersection are likely to meet the MUTCD traffic signal warrants. However, installation of a traffic signal system is not recommended since it would increase the overall average delay experienced at this intersection, causing the eastbound and westbound Koloa Road through traffic, presently free or unrestricted movements, to stop once per cycle. In addition, the relatively short intersection offset distance (approximately 460 feet) between Poipu Road and Maluhia Road will make this intersection difficult to signalize. The projected queue lengths for the westbound Koloa Road left-turn traffic movement are anticipated to exceed the existing left-turn lane storage length and may block the westbound through lane on Koloa Road, impacting the operation of the Koloa Road/Maluhia Road intersection.

Koloa Road/Weliweli Road

The Weliweli Road northbound shared right-turn/left-turn traffic operates at LOS B during the AM peak hour of traffic and at LOS C during the PM peak hour of traffic. The Koloa Road westbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic.

Weliweli Road/Hapa Road

The Weliweli Road northbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic. The Hapa Road eastbound right-turn and left-turn traffic operates at LOS A during the AM and PM peak hours of traffic.

Weliweli Road/Ala Kinoiki Road

The Ala Kinoiki Road northbound and southbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic. The Weliweli Road westbound shared right-turn/through/left-turn traffic operates at LOS B during the AM peak hour of traffic and at LOS C during the PM peak hour of traffic. The Weliweli Road eastbound shared right-turn/through/left-turn traffic operates at LOS B during the AM and PM peak hours of traffic.

Poipu Road/Ala Kinoiki Road/Pee Road

The Poipu Road eastbound left-turn and westbound shared through/left-turn traffic, and the Ala Kinoiki Road southbound right-turn traffic operates at LOS A during the AM and PM peak hours of traffic. The Pee Road northbound shared right-turn/through/left-turn traffic operates at LOS B during the AM peak hour of traffic and at LOS D during the PM peak hour of traffic. The Ala Kinoiki Road southbound shared through/left-turn traffic operates at LOS B during the AM peak hour of traffic and LOS C during the PM peak hour of traffic.

Table 2
Existing Level of Service Summary

	Existing			
	AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Koloa Road				
NB RT	B	11.1	B	13.3
NB LT	C	21.5	*F	>50
WB LT	A	8.9	A	9.4
Koloa Road/Maluhia Road				
SB RT	A	9.7	B	13.8
SB LT	B	14.5	E	46.2
EB LT	A	7.7	A	9.1
Maluhia Road/Ala Kinoiki Road				
SB LT	A	7.7	A	8.2
WB RT	FREE	--	FREE	--
WB LT	A	0	C	20.2
Koloa Road/Weliweli Road				
NB RT/LT	B	12.2	C	15.3
WB LT	A	8.3	A	8.3
Weliweli Road/Hapa Road				
WB LT	A	7.6	A	7.4
NB RT	A	9.3	A	8.8
NB LT	A	10	A	10
Ala Kinoiki Road/Weliweli Road				
NB LT	A	7.6	A	7.9
SB LT	A	7.5	A	7.7
WB RT/TH/LT	B	10.5	C	16.3
EB RT/TH/LT	B	10.8	B	11.1
Poipu Road/Ala Kinoiki Road/Pee Road				
NB RT/TH/LT	B	12.9	D	26.6
SB RT	FREE	--	FREE	--
SB TH/LT	B	14.9	C	23.3
WB LT/TH	A	7.4	A	7.6
EB LT	A	7.4	A	7.9
Poipu Road/Kipuka Street				
SB RT/LT	A	9.9	B	11.9
EB LT	A	7.6	A	7.9
Poipu Road/Hoowili Road				
NB RT	A	9.3	B	10.2
NB LT	B	11.3	C	17
WB LT	A	7.7	A	8.1
Poipu Road/Kiahuna Tennis Club Driveway				
SB RT/LT	A	9.9	B	12.4
EB LT	A	7.6	A	8.1
Poipu Road/Kiahuna Plantation Drive				
NB RT/TH/LT	B	11.2	C	23.6
SB RT/TH/LT	B	11.2	C	19.9
WB LT	A	7.7	A	9.1
EB LT	A	7.6	A	8.3

Note: Delay is in seconds
LOS - Level of Service
* = Volume to Capacity Ratio (v/c) >1.0

Poipu Road/Kiahuna Plantation Drive

The Kiahuna Plantation Drive northbound and southbound shared right-turn/through/left-turn traffic operates at LOS B during the AM peak hour of traffic and at LOS C during the PM peak hour of traffic. The Poipu Road westbound and eastbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic.

Poipu Road/Hoowili Road

The Hoowili Road northbound left-turn traffic operates at LOS B during the AM peak hour of traffic and at LOS C during the PM peak hour of traffic. The Hoowili Road northbound right-turn traffic operates at LOS A during the AM peak hour of traffic and LOS B during the PM peak hour of traffic. The Poipu Road westbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic.

Poipu Road/Kipuka Street

The Kipuka Street southbound shared right-turn/left-turn traffic operates at LOS A during the AM peak hour of traffic and at LOS B during the PM peak hour of traffic. The Poipu Road eastbound left-turn traffic operates at LOS A during the AM and PM peak hours of traffic.

Figure 4 shows the existing turning movement volumes and LOS within the study area.

III. BASE YEAR CONDITIONS WITHOUT THE PROJECT

The methodologies used to develop base year traffic projections without Project-generated traffic are described below:

A. Background Traffic Growth

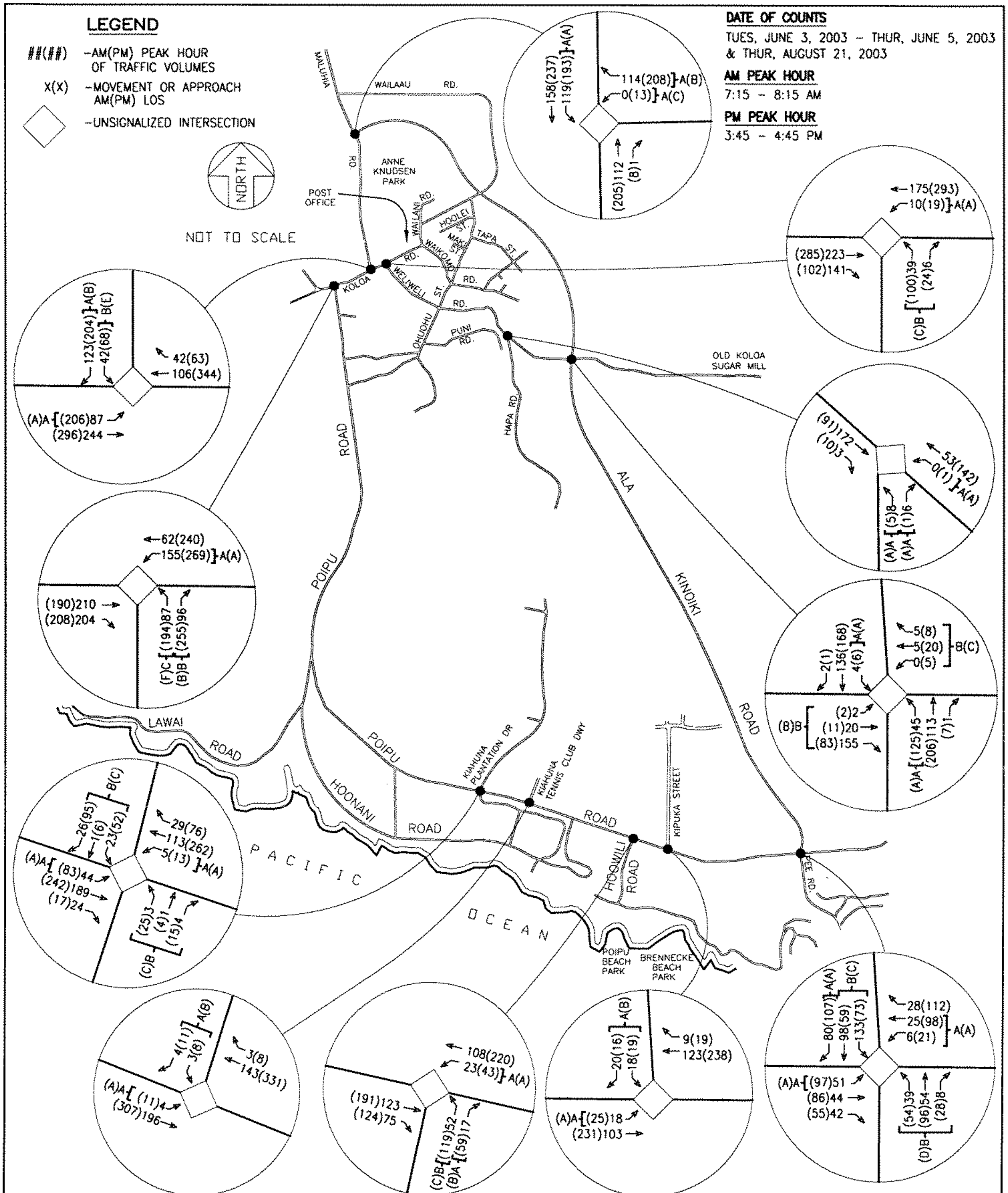
Base year conditions without the Project were estimated for Years 2006, 2010, and 2015. These base years were selected based on the development schedule for the Project. A review of historic average daily traffic data obtained from the State of Hawaii, Department of Transportation's Traffic Summary – Island of Kauai – 1999, indicates that traffic volumes have generally decreased after 1992 due to Hurricane Iniki. De facto growth rates were derived from historic average daily traffic data contained in the Traffic Summary – Island of Kauai – 1999 for the years between these two events and the Year 2020 traffic projections for the Koloa and Poipu area that are contained in the Kauai Long Range Land Transportation Plan –1997. An annual growth rate of 3 percent per year was derived from the two data sources and was applied to existing 2003 volumes to project base year traffic volumes.

B. Other Known Developments

The following are descriptions of new/future developments near the Project that may have a significant impact on traffic operations in the study area. Traffic volumes generated by these developments were obtained from traffic reports if one was available. Traffic volumes were estimated using trip rates contained in the Institute of Transportation Engineers (ITE) Trip Generation, 7th Edition for those developments for which a traffic report was not available. Table 3 shows the trip rates contained in ITE Trip Generation, 7th Edition.

Koloa Creekside is anticipated to be constructed in 2006 and is expected to consist of eight (8) single-family detached units and 72 multi-family units. The proposed location of Koloa Creekside is bordered by Weliweli Road to the north and Waikomo Road to the east, and is more specifically identified as TMK: 2-8-009:001. Since a traffic study for Koloa Creekside was not available at the time of this writing, traffic generated by this project was estimated using trip rates contained in ITE Trip Generation, 7th Edition and distributed according to existing traffic patterns. Traffic generated by Koloa Creekside is included in traffic projections for Base Year 2006 and beyond.

The **Poipu Beach Hotel**, which is located on the south side of Poipu Road and west of Hoowili Road, was closed in 2001 due to damage from Hurricane Iniki. The hotel is anticipated to be renovated and reopened by December 2006, and is expected to consist of 121 hotel units and a restaurant. Since a traffic study for renovation of the Poipu Beach Hotel was not available at the time of this writing, traffic generated by this project was estimated using trip rates contained in ITE Trip Generation, 7th Edition and distributed according to existing traffic patterns. Traffic generated by renovation of the Poipu Beach Hotel is included in traffic projections for Base Year 2006 and beyond.



ERIC KNUDSEN TRUST VILLAGE AT POIPU 2005 UPDATE	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS, SURVEYORS • HONOLULU, HAWAII EXISTING TRAFFIC VOLUMES AND LOS	FIGURE 4

The **Koloa Marketplace** will be constructed in two phases. Phase 1 is anticipated to be constructed by 2007 and is expected to consist of 18,500 square feet (SF) restaurant and 26,500 SF retail space. Phase 2 is anticipated to be constructed by 2009 and is expected to consist of 12,000 SF office, 4,200 SF restaurant and 4,300 SF retail space. The proposed location of the Koloa Marketplace is at the northeast corner of the intersection of Koloa Road and Maluhia Road, and is more specifically identified as TMK: 2-8-004:003. The Koloa Marketplace Traffic Impact Report, dated November 2001, prepared by Austin, Tsutsumi & Associates, Inc. was not based on the current land use and development schedule for Koloa Marketplace. Therefore, traffic generated by Koloa Marketplace was estimated using trip rates contained in ITE Trip Generation, 7th Edition and distributed according to traffic volumes in the Koloa Marketplace Traffic Impact Report. Traffic generated by the Koloa Marketplace is included in traffic projections for Base Year 2010 and beyond.

The **Historic Koloa Village** is anticipated to be constructed by 2008 and is expected to consist of 31 multi-family residences, 22,500 SF retail space and 22,500 SF office space. The proposed location of the Historic Koloa Village is bordered by Koloa Road, Weliweli Road and Waikomo Road, and is more specifically identified by TMK: 2-8-008:001. Since a traffic study for the Historic Koloa Village was not available at the time of this writing, traffic generated by this project was estimated using trip rates contained in ITE Trip Generation, 7th Edition and distributed according to existing traffic patterns. Traffic generated by the Historic Koloa Village is included in traffic projections for Base Year 2010 and beyond.

The **Poipu Beach Villas** is anticipated to be constructed by 2008 and will consist of 324 multi-family units. All 324 multi-family units were assumed to be recreational homes. Traffic generated by the Poipu Beach Villas was obtained from the Traffic Assessment Report for the Poipu Beach Villas, dated August 9, 2004, prepared by The Traffic Management Consultant. These traffic volumes were distributed according to existing traffic patterns since the Traffic Assessment Report for the Poipu Beach Villas did not show the distribution of traffic generated by the Poipu Beach Villas. Traffic generated by the Poipu Beach Villas is included in traffic projections for Base Year 2010 and beyond.

The expansion of the existing **Sheraton Kauai Resort Hotel** will consist of four phases on two sites, the North Site and the South Site. Phase 1 of the North Site is anticipated to be constructed by December 2009 and is expected to consist of 75 timeshare units. Phase 2 of the North Site is anticipated to be constructed by December 2010 and is expected to consist of 79 timeshare units. Phase 1 of the South Site is anticipated to be constructed by December 2011 and is expected to consist of 110 timeshare units. Phase 2 of the South Site is anticipated to be constructed by December 2012 and is expected to consist of 125 timeshare units. In addition, 227 existing hotel rooms will be demolished for construction of the South Site timeshare units. Traffic volumes generated by the expansion of the Sheraton Kauai Resort Hotel during the PM peak hour of traffic were obtained from the Sheraton Kauai Village Traffic Study, dated May 23, 2005, prepared by CH2MHill. Since the Sheraton Kauai Village Traffic Study did not analyze conditions during the AM peak hour of traffic, traffic volumes generated by the expansion of the Sheraton Kauai Resort Hotel during the AM peak hour of traffic were estimated using trip rates contained in ITE Trip Generation, 7th Edition and distributed according to existing traffic patterns. Traffic generated by construction of the North Site is included in traffic projections for Base Year 2010 and beyond. Traffic generated by construction of the South Site and demolition of 227 existing hotel rooms is included in traffic projections for Base Year 2015 and beyond.

Kukui'Ula Employee Housing is expected to be constructed by July 2008 and will be located along the east side of Poipu Road. Traffic generated by the Kukui'Ula Employee Housing was obtained from the Kukui'Ula Employee Housing Project Traffic Assessment, dated August 2004, prepared by Austin, Tsutsumi & Associates, Inc. The Kukui'Ula Employee Housing Project Traffic Assessment assumes 28 single-family units and 72 multi-family units. However, the exact unit count for the Kukui'Ula Employee Housing has not been determined at the time of this writing. Traffic generated by the Kukui'Ula Employee Housing is included in traffic projections for Base Year 2010 and beyond.

Kukui'Ula is proposed to have 1,500 residential units, a 64-room resort hotel, an 18-hole golf course, recreational facilities, commercial areas, community parks and an elementary school on approximately 1,022 acres located west of the Koloa-Poipu area. Traffic projections generated by the proposed Kukui'Ula development were obtained from the Kukui'Ula Traffic Impact Report, dated March 2003, prepared by Austin, Tsutsumi & Associates, Inc.

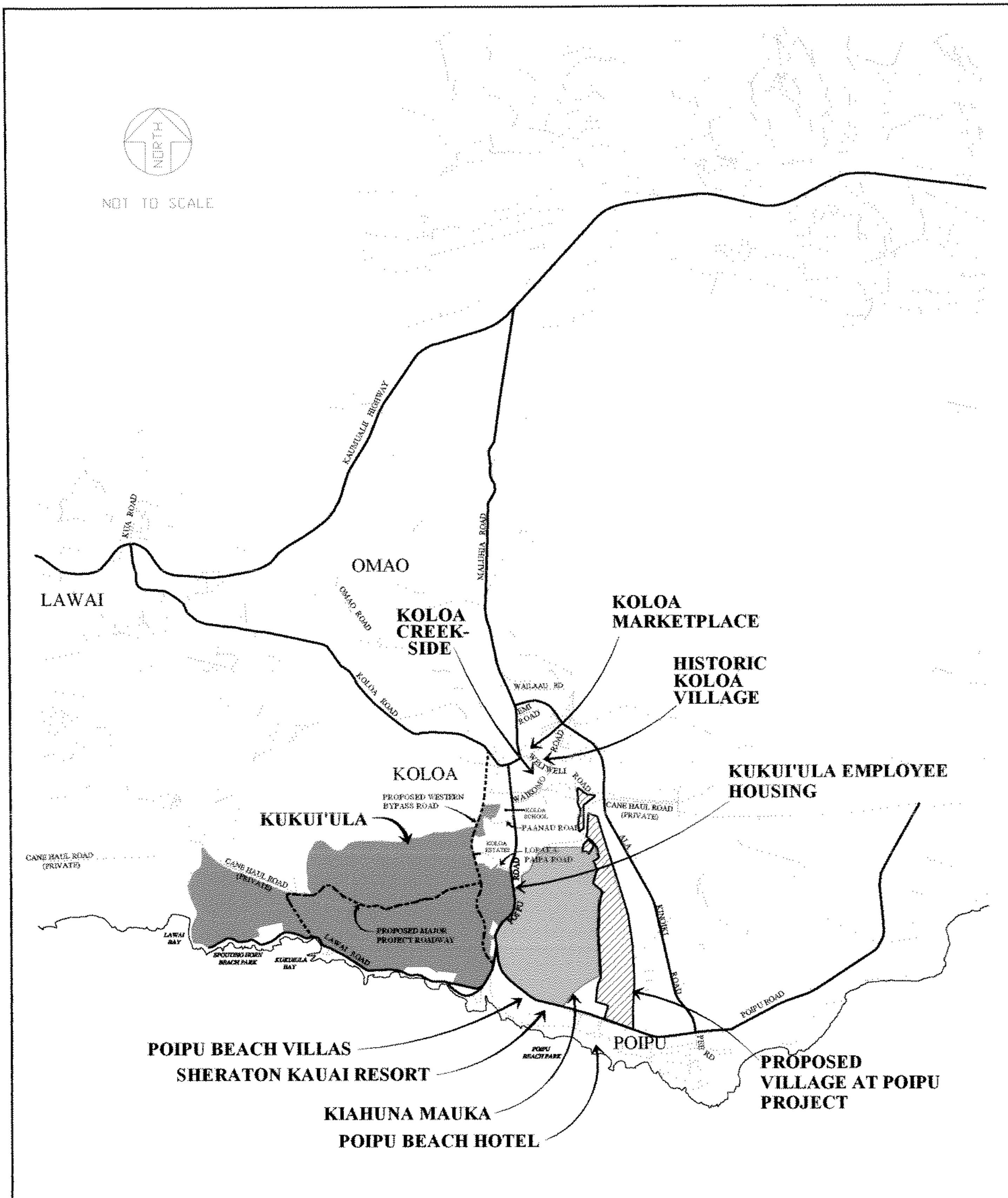
Kiahuna Mauka is proposed to be a 178-unit single-family and 635-unit multi-family residential subdivision between Poipu Road and Kiahuna Plantation Drive. Access to Kiahuna Mauka will be through Kiahuna Plantation Drive and directly off Poipu Road. This traffic study assumes that 635 multi-family units would be completed by Year 2010, and that the balance, 178 single-family units, will be completed after Year 2015. Since a traffic study for Kiahuna Mauka was not available at the time of this writing, traffic generated by this project was estimated using trip rates contained in ITE Trip Generation, 7th Edition and distributed according to existing traffic patterns. Traffic generated by the 635 multi-family units of Kiahuna Mauka is included in traffic projections for Base Year 2010 and beyond.

Figure 5 shows the locations of the new/future developments near the Project and Table 4 summarizes the traffic generated by these developments.

Table 3
Trip Generation Rates
For Other Known Developments Without a Traffic Study

Land Use (ITE Code)	Indepen-dent Variable	Daily Trip Rate	AM Peak Hour of Traffic		PM Peak Hour of Traffic	
			Trip Rate	% Enter	Trip Rate	% Enter
Single-Family Home (210)	DU	A	b	25%	c	63%
Multi-Family Home (230)	DU	d	e	17%	f	67%
Recreational Home (260)	DU	3.16	0.16	67%	0.26	41%
Hotel (310)	Rooms	G	h	61%	0.59	53%
Office (710)	1000 SF GFA	i	j	88%	k	17%
Retail (820)	1000 SF GLA	L	m	61%	n	48%
Restaurant (932)	1000 SF GFA	127.15	11.52	52%	10.92	61%

T= number of trips ends	a	Ln(T)= 0.92*Ln(X)+2.71
X= independent variable	b	T= 0.70*X+9.43
DU= dwelling units	c	Ln(T)= 0.90*Ln(X)+0.53
SF= square feet	d	Ln(T)= 0.85*Ln(X)+2.55
GFA= gross floor area	e	Ln(T)= 0.80*Ln(X)+0.26
GLA= gross leasable area	f	Ln(T)= 0.82*Ln(X)+0.32
	g	T= 8.95*X-373.16
	h	Ln(T)= 1.24*Ln(X)-2.00
	i	Ln(T)= 0.77*Ln(X)+3.65
	j	Ln(T)= 0.80*Ln(X)+1.55
	k	T= 1.12*X+78.81
	l	Ln(T)= 0.65*Ln(X)+5.83
	m	Ln(T)= 0.60*Ln(X)+2.29
	n	Ln(T)= 0.66*Ln(X)+3.40



ERIC KNUDSEN TRUST
VILLAGE AT POIPU
2005 UPDATE

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
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OTHER KNOWN DEVELOPMENTS

FIGURE 5

Table 4
Trip Generation Summary for Other Known Developments

Planned Developments without Village at Poipu	UNITS	AM PEAK HOUR			PM PEAK HOUR		
		IN	OUT	TOTAL	IN	OUT	TOTAL
Base Year 2006							
Koloa Creekside							
Single-Family Home	8 DU	4	11	15	7	4	11
Multi-Family Home	72 DU	7	33	40	31	15	46
Poipu Beach Hotel							
Hotel	121 rooms	32	20	52	38	33	71
Subtotal Base Year 2006		***43***	***64***	***107***	***76***	***52***	***128***
Base Year 2010							
Koloa Marketplace							
Retail	30,800 SF	58	37	95	162	177	339
Restaurant	22,700 SF	136	125	261	151	97	248
Office	12,000 SF	30	4	34	16	76	92
Historic Koloa Village							
Multi-Family Home	31 DU	3	17	20	15	8	23
Office	22,500 SF	50	7	57	18	86	104
Retail	22,500 SF	39	25	64	112	122	234
Poipu Beach Villas							
Recreational Home	324 DU	35	17	52	35	50	85
Sheraton Kauai Resort Hotel							
Recreational Home	154 DU	17	8	25	16	25	41
Kukui'Ula Employee Housing							
Single-Family Home	28 DU	7	22	29	21	13	34
Multi-Family Home	72 DU	7	33	40	31	15	46
Kukui'Ula							
Hotel	183 rooms	23	9	32	21	27	48
Recreational Home	945 DU	103	51	154	102	146	248
Single-Family Home	80 DU	19	56	75	61	33	94
Restaurant	5,000 SF	1	0	1	16	22	38
Golf Course	240 AC	36	12	48	21	41	62
Community Park	23 AC	9	3	12	5	9	14
Recreation Center	15,000 SF	13	7	20	9	18	27
Subtotal Base Year 2010		***586***	***433***	***1,019***	***812***	***965***	***1,777***

Planned Developments without Village at Poipu	UNITS	AM PEAK HOUR			PM PEAK HOUR		
		IN	OUT	TOTAL	IN	OUT	TOTAL
Base Year 2015							
Sheraton Kauai Resort Hotel							
Recreational Home	235 DU	25	12	37	25	36	61
Hotel	-227 rooms	-36	-14	-50	-39	-54	-93
Kukui'Ula							
Recreational Home	287 DU	31	15	46	31	44	75
Single-Family Home	85 DU	17	52	69	60	33	93
Commercial	50,000 SF	65	41	106	191	206	397
School	300	51	36	87	32	46	78
Kiahuna Mauka							
Multi-Family Home	318 DU	22	108	130	104	51	155
Recreational Home	317 DU	34	17	51	34	48	82
Subtotal Base Year 2015		***209***	***267***	***476***	***438***	***410***	***848***
Total Base Years 2006, 2010 and 2015		***838***	***764***	***1,602***	***1,326***	***1,427***	***2,753***

DU= dwelling units
SF= square feet
AC= acres

C. Planned Roadway Projects

Western Bypass Road

The Western Bypass Road is proposed to be a north-south road, constructed as part of the Kukui'Ula development that would provide an alternate route between the Poipu Road/Lawai Road intersection and Koloa Road. The Western Bypass Road would be constructed west and parallel to Poipu Road. The traffic study for Kukui'Ula estimates that the Western Bypass Road would be constructed from the Poipu Road/Lawai Road intersection to Koloa Road at the time 750 dwelling units are completed, as part of the Kukui'Ula development. Therefore, this study assumes that this portion of the Western Bypass Road will be completed prior to Year 2010. The completion of the north leg of the Western Bypass that extends from Koloa Road to intersect Maluhia Road directly across of Ala Kinoiki Road is dependent on the resolution of right-of-way issues and therefore, will not be considered in this study.

D. Base Year 2006 Conditions Without the Project

The results of the intersection analyses for Base Year 2006 conditions are summarized in Table 5.

1. Base Year 2006 Traffic Operations

The following are the individual turning movements or intersections that will operate at LOS E or LOS F conditions.

Koloa Road/Maluhia Road

The Maluhia Road southbound left-turn traffic will change from LOS E to LOS F during the PM peak hour of traffic. Base Year 2006 traffic volumes at this intersection may meet the MUTCD traffic signal warrants. However, installation of a traffic signal system is not recommended since it would increase the overall average delay experienced at this intersection, causing the eastbound and westbound Koloa Road through traffic, presently free or unrestricted movements, to stop once per cycle. In addition, the relatively short intersection offset distance (approximately 460 feet) between Maluhia Road and Poipu Road will make this intersection difficult to signalize. The projected queue lengths for the eastbound Koloa Road left-turn traffic movement are anticipated to exceed the existing left-turn lane storage length and may block the eastbound through lane on Koloa Road, impacting the operation of the Koloa Road/Poipu Road intersection. As previously mentioned, southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Koloa Road/Poipu Road

The Poipu Road northbound left-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection.

Table 5
Base Year 2006 Level of Service Summary

	Existing				Base 2006				Base 2006 with Mitigative Measures			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Koloa Road												
NB RT	B	11.1	B	13.3	B	11.7	B	15	--	--	--	--
NB LT	C	21.5	*F	>50	D	27	*F	>50	--	--	--	--
WB LT	A	8.9	A	9.4	A	9.2	A	10	--	--	--	--
Koloa Road/Maluhia Road												
SB RT	A	9.7	B	13.8	B	10.1	C	15.5	--	--	--	--
SB LT	B	14.5	E	46.2	C	16.5	F	>50	--	--	--	--
EB LT	A	7.7	A	9.1	A	7.9	A	9.6	--	--	--	--
Maluhia Road/Ala Kinoiki Road												
SB LT	A	7.7	A	8.2	A	7.9	A	8.5	--	--	--	--
WB RT	FREE	--	FREE	--	FREE	--	FREE	--	--	--	--	--
WB LT	A	0	C	20.2	B	14.9	C	25	--	--	--	--
Koloa Road/Weliweli Road												
NB RT/LT	B	12.2	C	15.3	B	14.7	C	24.9	--	--	--	--
WB LT	A	8.3	A	8.3	A	8.3	A	8.5	--	--	--	--
Weliweli Road/Hapa Road												
WB LT	A	7.6	A	7.4	A	7.7	A	7.5	--	--	--	--
NB RT	A	9.3	A	8.8	A	9.5	A	9	--	--	--	--
NB LT	A	10	A	10	B	10.4	B	10.5	--	--	--	--
Ala Kinoiki Road/Weliweli Road												
NB LT	A	7.6	A	7.9	A	7.7	A	8.1	--	--	--	--
SB LT	A	7.5	A	7.7	A	7.5	A	7.8	--	--	--	--
WB RT/TH/LT	B	10.5	C	16.3	B	12.6	C	21.1	--	--	--	--
EB RT/TH/LT	B	10.8	B	11.1	B	11.8	B	13.1	--	--	--	--
Poipu Road/Ala Kinoiki Road/Pee Road												
NB RT/TH/LT	B	12.9	D	26.6	C	15.4	F	>50	A	9.2	B	10.8
SB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--
SB TH/LT	B	14.9	C	23.3	C	19.5	E	42.4	B	13.5	B	12.8
WB LT/TH	A	7.4	A	7.6	A	7.5	A	7.7	A	9.7	B	12.4
WB RT	--	--	--	--	--	--	--	--	A	8.6	B	10.4
EB LT	A	7.4	A	7.9	A	7.5	A	8.1	B	10.4	B	12.5
EB RT/TH	--	--	--	--	--	--	--	--	A	9.8	B	12.1
OVERALL	--	--	--	--	--	--	--	--	**B	**10.8	**B	**11.6

* = Volume to Capacity Ratio (v/c) > 1.0
** = All-Way-Stop-Sign Control Configuration
Note: Delay is in seconds
LOS - Level of Service

Table 5
Base Year 2006 Level of Service Summary

	Existing				Base 2006				Base 2006 with Mitigative Measures			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Kipuka Street												
SB RT/LT	A	9.9	B	11.9	B	10.3	B	13.3	--	--	--	--
EB LT	A	7.6	A	7.9	A	7.7	A	8.1	--	--	--	--
Poipu Road/Hoowili Road												
NB RT	A	9.3	B	10.2	A	9.5	B	10.7	--	--	--	--
NB LT	B	11.3	C	17	B	12.4	C	22	--	--	--	--
WB LT	A	7.7	A	8.1	A	7.8	A	8.3	--	--	--	--
Poipu Road/Kiahuna Tennis Club Driveway												
SB RT/LT	A	9.9	B	12.4	B	10.4	B	13.3	--	--	--	--
EB LT	A	7.6	A	8.1	A	7.6	A	8.2	--	--	--	--
Poipu Road/Kiahuna Plantation Drive												
NB RT/TH/LT	B	11.2	C	23.6	B	12.9	D	26.3	--	--	--	--
SB RT/TH/LT	B	11.2	C	19.9	B	12.6	D	27	--	--	--	--
WB LT	A	7.7	A	9.1	A	7.8	A	8	--	--	--	--
EB LT	A	7.6	A	8.3	A	7.7	A	8.5	--	--	--	--

* = Volume to Capacity Ratio (v/c) > 1.0
** = All-Way-Stop-Sign Control Configuration
Note: Delay is in seconds
LOS - Level of Service

Poipu Road/Ala Kinoiki Road/Pee Road

The Pee Road northbound shared right-turn/through/left-turn traffic will change from LOS D to LOS F during the PM peak hour of traffic. The southbound shared through/left-turn traffic will change from LOS C to LOS E during the PM peak hour of traffic.

2. Base Year 2006 Traffic Mitigation Measures

Poipu Road/Ala Kinoiki Road/Pee Road

Base Year 2006 traffic volumes at the Poipu Road/Ala Kinoiki Road/Pee Road intersection are not likely to meet the MUTCD traffic signal warrants. However, an all-way-stop-controlled (AWSC) intersection may be warranted per the criteria from the MUTCD. As an AWSC intersection, this intersection will operate overall at LOS B with all individual movements operating at LOS B or better during the AM peak hour of traffic and PM peak hours of traffic.

An alternative to mitigate LOS F conditions in lieu of an AWSC intersection would be the installation of a single-lane roundabout. Recently, roundabouts have become increasingly popular because of their ability to reduce injury and fatal crashes, slow traffic, reduce maintenance cost, and improve the aesthetics of an intersection. In addition, roundabouts can accommodate up to 30 percent more vehicular traffic with less delay than signalized or stop-controlled intersections. The definition of a "roundabout" and other types of circular intersections are described in Appendix D, as the terms used to describe circular intersections are often misunderstood and incorrectly interchanged.

A review of the State Tax Map Key Plans shows that Poipu Road has an approximate 70-foot wide right-of-way at its intersection with Ala Kinoiki Road and Pee Road. A roundabout may not feasible at this location unless additional right-of-way is acquired. Furthermore, additional engineering studies will be required to determine the feasibility of the construction of a roundabout at this intersection, given the additional right-of-way.

The RODEL computer software was used to analyze roundabout LOS. RODEL was developed in Great Britain and was designed to facilitate experimentation with the geometric design parameters as part of the roundabout design process. In addition, LOS and roundabout capacity estimates by RODEL have been validated by direct field observations. RODEL was used in the analysis as the HCM 2000 provides only cursory capacity analysis for roundabouts and does not calculate an overall LOS. Should a single-lane roundabout be constructed, traffic at this intersection will operate overall at LOS A during the AM and PM peak hours of traffic.

Figure 6 shows the traffic volumes and LOS for Base Year 2006 with mitigation measures.

E. Base Year 2010 Conditions Without the Project

The Base Year 2010 traffic assignment considers the construction of the Western Bypass Road between the Poipu Road/Lawai Road intersection and Koloa Road. The Western Bypass Road will provide an additional north-south route, however, other north-south routes, such as the extension of the Western Bypass from Koloa Road to Maluhia Road, need to be considered to serve the regional demands of the Poipu/Kukuiula area.

The study intersections LOS for Base Year 2010 are summarized in Table 6.

1. Base Year 2010 Traffic Operations

The following are the individual turning movements or intersections that will operate at LOS E or LOS F conditions.

Koloa Road/Maluhia Road

The Maluhia Road southbound right-turn traffic will change from LOS C to LOS F during the PM peak hour of traffic. The Maluhia Road southbound left-turn traffic will change from LOS C to LOS E during the AM peak hour of traffic and will continue to operate at LOS F during the PM peak hour of traffic. Southbound traffic at this intersection will operate at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Poipu Road intersection. Southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Koloa Road/Poipu Road

The Poipu Road northbound right-turn traffic will change from LOS B to LOS E during the PM peak hour of traffic. The Poipu Road northbound left-turn traffic will change from LOS D to LOS E during the AM peak hour of traffic and will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Northbound traffic on Poipu Road will be able to use the Western Bypass as an alternate route to Koloa Road.

Maluhia Road/Ala Kinoiki Road

The Ala Kinoiki Road westbound left-turn traffic will change from LOS C to LOS F during the PM peak hour of traffic. Base Year 2010 traffic volumes at the Maluhia Road/Ala Kinioiki Road intersection are not likely to meet MUTCD traffic signal warrants. It is not uncommon, however, for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway. There are only 5 and 20 westbound vehicles on Ala Kinoiki Road that are projected to turn left onto Maluhia Road during the AM and PM peak hours of traffic, respectively.

Koloa Road/Weliweli Road

The Weliweli Road northbound traffic, which is served by a shared right-turn/left turn lane, will change from LOS C to LOS F and will operate at overcapacity conditions during the PM peak hour of traffic. There is an increase in northbound right-turn traffic on Weliweli Road, of which 42 and 48 vehicles would be generated by the Koloa Marketplace during the AM and PM peak hours of traffic, respectively. Also, there is an increase in northbound left-turn traffic on Weliweli Road, of which 29 and 130 vehicles would be generated by the Historic Koloa Village.

<u>Ala Kinoiki Road/Weliweli Road</u>

The Weliweli Road westbound traffic, which is served by a shared right-turn/through/left-turn lane, will change from LOS C to LOS E during the PM peak hour of traffic primarily due to increased through traffic on Ala Kinoiki Road.

<u>Poipu Road/Hoowili Road</u>

The Hoowili Road northbound left-turn traffic will change from LOS C to LOS F during the PM peak hour of traffic primarily due to increased through traffic on Poipu Road.

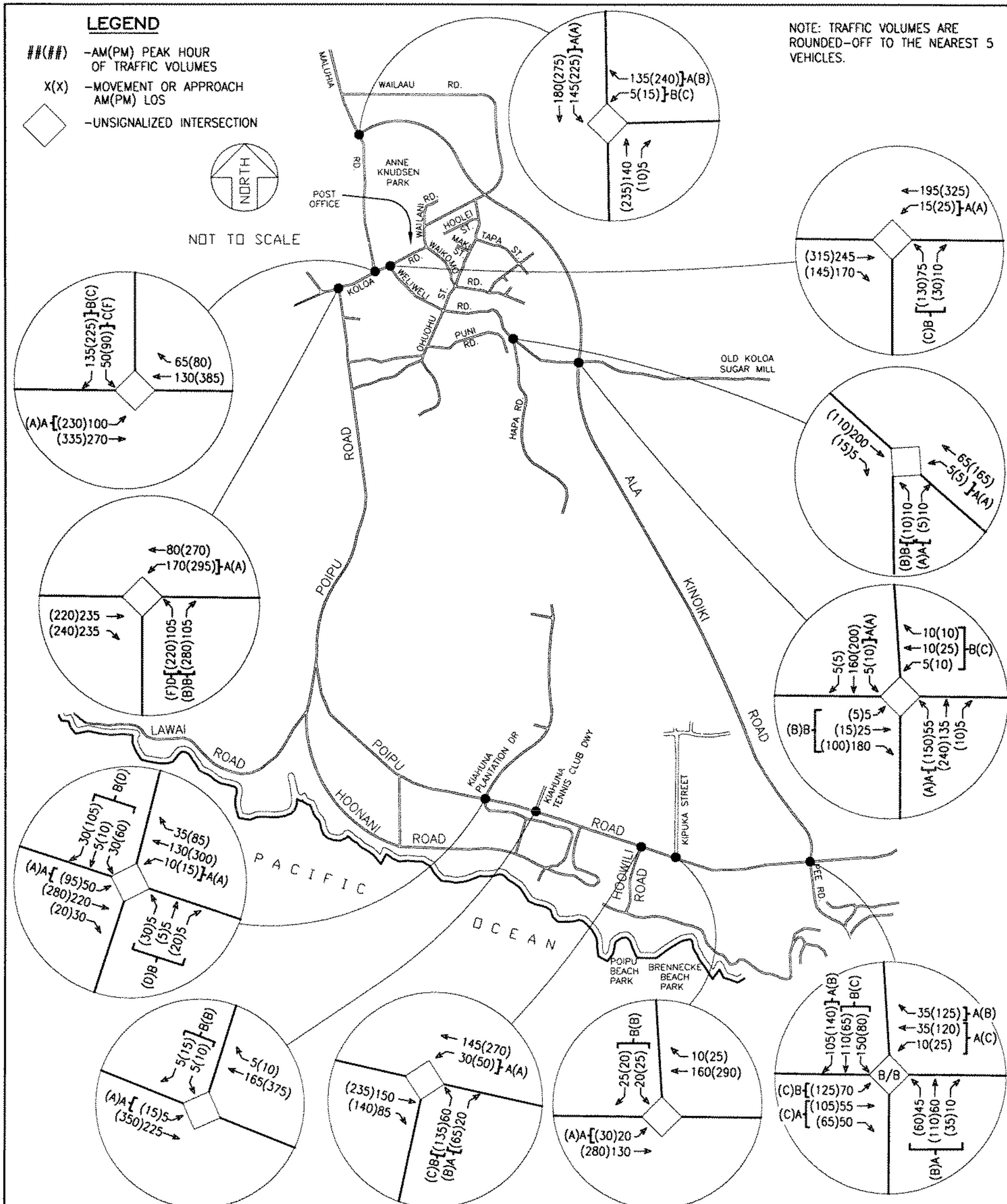
<u>Poipu Road/ Kiahuna Plantation Drive</u>

The Kiahuna Plantation Drive northbound shared right-turn/through/left-turn traffic and southbound shared right-turn/through/left-turn traffic will change from LOS D to LOS F during the PM peak hour of traffic. Southbound traffic on Kiahuna Plantation Drive will operate at overcapacity conditions during the PM peak hour of traffic. LOS F conditions are primarily due to increased through traffic on Poipu Road.

2. Base Year 2010 Traffic Mitigation Measures

<u>Koloa Road/Weliweli Road</u>

Modify the Weliweli Road northbound approach to Koloa Road to provide an exclusive right-turn lane and an exclusive left-turn lane. With this improvement, northbound right-turn traffic will improve to LOS B during the AM and PM peak hours of traffic. Northbound left-turn traffic will continue to operate at LOS D during the AM peak hour of traffic, and at LOS F and overcapacity conditions during the PM peak hour of traffic.



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2005 UPDATE

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BASE YEAR 2006 WITH MITIGATION MEASURES
TRAFFIC VOLUMES AND LOS

FIGURE 6

Table 6
Base Year 2010 Level of Service Summary

	Existing				Base 2006 with Mitigative Measures				Base 2010				Base 2010 with Mitigative Measures			
	AM		PM		AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Koloa Road																
NB RT	B	11.1	B	13.3	B	11.7	B	15	C	15.3	E	37.3	--	--	--	--
NB LT	C	21.5	*F	>50	D	27	*F	>50	E	41.2	*F	>50	--	--	--	--
WB LT	A	8.9	A	9.4	A	9.2	A	10	A	9.6	B	11.9	--	--	--	--
Koloa Road/Maluhia Road																
SB RT	A	9.7	B	13.8	B	10.1	C	15.5	B	12.8	*F	>50	--	--	--	--
SB LT	B	14.5	E	46.2	C	16.5	F	>50	E	42.1	*F	>50	--	--	--	--
EB LT	A	7.7	A	9.1	A	7.9	A	9.6	A	8.7	B	15	--	--	--	--
Maluhia Road/Ala Kinoiki Road																
SB LT	A	7.7	A	8.2	A	7.9	A	8.5	A	8.4	A	9.9	--	--	--	--
WB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	--	--	--	--
WB LT	A	0	C	20.2	B	14.9	C	25	C	21.9	F	>50	--	--	--	--
Koloa Road/Weliweli Road																
NB RT/LT	B	12.2	C	15.3	B	14.7	C	24.9	D	30.2	*F	>50	--	--	--	--
NB RT	--	--	--	--	--	--	--	--	--	--	--	--	B	12.4	B	14.4
NB LT	--	--	--	--	--	--	--	--	--	--	--	--	D	29.2	*F	>50
WB LT	A	8.3	A	8.3	A	8.3	A	8.5	A	9.2	A	9.8	A	9.2	A	9.8
Weliweli Road/Hapa Road																
WB LT	A	7.6	A	7.4	A	7.7	A	7.5	A	7.9	A	7.7	--	--	--	--
NB RT	A	9.3	A	8.8	A	9.5	A	9	A	9.9	A	9.4	--	--	--	--
NB LT	A	10	A	10	B	10.4	B	10.5	B	11.6	B	12	--	--	--	--
Ala Kinoiki Road/Weliweli Road																
NB LT	A	7.6	A	7.9	A	7.7	A	8.1	A	7.9	A	8.4	--	--	--	--
SB LT	A	7.5	A	7.7	A	7.5	A	7.8	A	7.6	A	7.9	--	--	--	--
WB RT/TH/LT	B	10.5	C	16.3	B	12.6	C	21.1	B	14.2	E	37.2	--	--	--	--
EB RT/TH/LT	B	10.8	B	11.1	B	11.8	B	13.1	C	16.1	C	16.4	--	--	--	--
OVERALL	--	--	--	--	--	--	--	--	--	--	--	--	***A	***3.8	***A	***4.5
Poipu Road/Ala Kinoiki Road/Pee Road																
NB RT/TH/LT	B	12.9	D	26.6	A	9.2	B	10.8	A	9.9	B	12.2	--	--	--	--
SB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	--	--	--	--
SB TH/LT	B	14.9	C	23.3	B	13.5	B	12.8	C	19.7	C	19.1	--	--	--	--
WB LT/TH	A	7.4	A	7.6	A	9.7	B	12.4	B	11.5	C	18.4	--	--	--	--
WB RT	--	--	--	--	A	8.6	B	10.4	A	9.6	B	13.2	--	--	--	--
EB LT	A	7.4	A	7.9	B	10.4	B	12.5	B	11.6	C	16	--	--	--	--
EB RT/TH	--	--	--	--	A	9.8	B	12.1	B	11.9	C	18.3	--	--	--	--
OVERALL	--	--	--	--	**B	**10.8	**B	**11.6	**B	**13.6	**C	**15.9	--	--	--	--

* = Volume to Capacity Ratio (v/c) > 1.0

** = All-Way-Stop-Sign Control Configuration

*** = Roundabout Configuration

Note: Delay is in seconds

LOS - Level of Service

Table 6
Base Year 2010 Level of Service Summary

	Existing				Base 2006 with Mitigative Measures				Base 2010				Base 2010 with Mitigative Measures			
	AM		PM		AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Kipuka Street																
SB RT/LT	A	9.9	B	11.9	B	10.3	B	13.3	B	11.7	C	17	--	--	--	--
EB LT	A	7.6	A	7.9	A	7.7	A	8.1	A	7.9	A	8.5	--	--	--	--
Poipu Road/Hoowili Road																
NB RT	A	9.3	B	10.2	A	9.5	B	10.7	B	10.1	B	12.5	--	--	--	--
NB LT	B	11.3	C	17	B	12.4	C	22	C	15.8	F	>50	--	--	--	--
WB LT	A	7.7	A	8.1	A	7.8	A	8.3	A	8.2	A	9.1	--	--	--	--
OVERALL	--	--	--	--	--	--	--	--	--	--	--	--	***A	***3.8	***A	***5.3
Poipu Road/Kiahuna Tennis Club Driveway																
SB RT/LT	A	9.9	B	12.4	B	10.4	B	13.3	B	11.6	C	18	--	--	--	--
EB LT	A	7.6	A	8.1	A	7.6	A	8.2	A	7.9	A	8.8	--	--	--	--
Poipu Road/Kiahuna Plantation Drive																
NB RT/TH/LT	B	11.2	C	23.6	B	12.9	D	26.3	C	17	F	>50	--	--	--	--
SB RT/TH/LT	B	11.2	C	19.9	B	12.6	D	27	C	16.2	*F	>50	--	--	--	--
WB LT	A	7.7	A	9.1	A	7.8	A	8	A	8.2	A	8.6	--	--	--	--
EB LT	A	7.6	A	8.3	A	7.7	A	8.5	A	8.1	A	9.4	--	--	--	--
OVERALL	--	--	--	--	--	--	--	--	--	--	--	--	***A	***4.0	***A	***5.6

* = Volume to Capacity Ratio (v/c) > 1.0

** = All-Way-Stop-Sign Control Configuration

Note: Delay is in seconds

LOS - Level of Service

*** = Roundabout Configuration

Base Year 2010 traffic volumes at this intersection may meet MUTCD traffic signal warrants even with an exclusive right-turn lane and an exclusive left-turn lane on the northbound approach. However, installation of a traffic signal system is not recommended since it would increase the overall average delay experienced at this intersection, causing the eastbound and westbound Koloa Road through traffic, presently free or unrestricted movements, to stop once per cycle. In addition, the close proximity to the Koloa Road/Maluhia Road intersection will make the Koloa Road/Weliweli Road intersection difficult to signalize. Northbound traffic on Weliweli Road can use Ohuohu Street and Waikomo Road as an alternate route to Koloa Town.

Ala Kinoiki Road/Weliweli Road

Base Year 2010 traffic volumes at this intersection may meet MUTCD traffic signal warrants should the Weliweli Road eastbound traffic continue to be served by a shared right-turn/through/left-turn lane. With the installation of a traffic signal, the Ala Kinoiki Road/Weliweli Road intersection will operate overall at LOS B and all individual movements will operate at LOS B or better during the AM and PM peak hours of traffic.

An alternative to a traffic signal system is the construction of a single-lane roundabout at this intersection. A review of the State Tax Map Key Plans shows that the Weliweli Road right-of-way is approximately 120 feet wide. It appears that a single-lane roundabout could be accommodated within the 120-foot right-of-way. Additional engineering studies will be required to determine the feasibility of constructing a single-lane roundabout at this intersection. Should a single-lane roundabout be constructed, traffic at this intersection will operate overall at LOS A during the AM and PM peak hours of traffic.

Base Year 2010 traffic volumes at this intersection are not likely to meet MUTCD traffic signal warrants if the Weliweli Road eastbound approach is modified to provide an exclusive right-turn lane and shared through/left-turn lane. However, westbound traffic would continue to operate at LOS E during the PM peak hour of traffic as an unsignalized intersection.

Poipu Road/Hoowili Road

Base Year 2010 traffic volumes at this intersection may meet the MUTCD traffic signal warrants. With the installation of a traffic signal, the Poipu Road/Hoowili Road intersection will operate overall at LOS A and all individual movements will operate at LOS C or better during the AM and PM peak hours of traffic.

An alternative to a traffic signal system is the construction of a single-lane roundabout at this intersection. A review of the State Tax Map Key Plans shows that the Poipu Road right-of-way is approximately 120 feet wide at its intersection with Hoowili Road. It appears that a single-lane roundabout could be accommodated within the 120-foot right-of-way. Additional engineering studies will be required to determine the feasibility of constructing a single-lane roundabout at this intersection. Should a single-lane roundabout be constructed, traffic at this intersection will operate overall at LOS A during the AM and PM peak hours of traffic.

Poipu Road/Kiahuna Plantation Drive

Base Year 2010 vehicular traffic volumes at this intersection are likely to warrant the installation of a traffic signal system. With the installation of a traffic signal, the Poipu Road/Kiahuna Plantation Drive intersection will operate overall at LOS A during the AM peak hour of traffic and LOS C during the PM peak hour of traffic. All individual movements will operate at LOS B or better during the AM peak hour of traffic and LOS C or better during the PM peak hour of traffic.

An alternative to a traffic signal system is the construction of a single-lane roundabout at this intersection. A review of the State Tax Map Key Plans shows that the Poipu Road right-of-way is approximately 120 feet wide at its intersection with Kiahuna Plantation Drive. It appears that a single-lane roundabout could be accommodated within the 120-foot right-of-way. Additional engineering studies will be required to determine the feasibility of constructing a single-lane roundabout at this intersection.

Should a single-lane roundabout be constructed, traffic at this intersection will operate overall at LOS A during the AM and PM peak hours of traffic.

Figure 7 shows the traffic volumes and LOS for Base Year 2010 with mitigation measures.

F. Base Year 2015 Conditions Without the Project

The Base Year 2015 traffic assignment considers the construction of the Western Bypass Road between the Poipu Road/Lawai Road intersection and Koloa Road. The results of the intersection analyses for Base Year 2015 conditions are summarized in Table 7.

1. Base Year 2015 Traffic Operations

The following are the individual turning movements or intersections that will operate at LOS E or F conditions.

Koloa Road/Maluhia Road

The Maluhia Road southbound right-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. The Maluhia Road southbound left-turn traffic will change from LOS E to LOS F and will operate at overcapacity conditions during the AM peak hour of traffic. The Maluhia Road southbound left-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Poipu Road intersection. Southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Koloa Road/Poipu Road

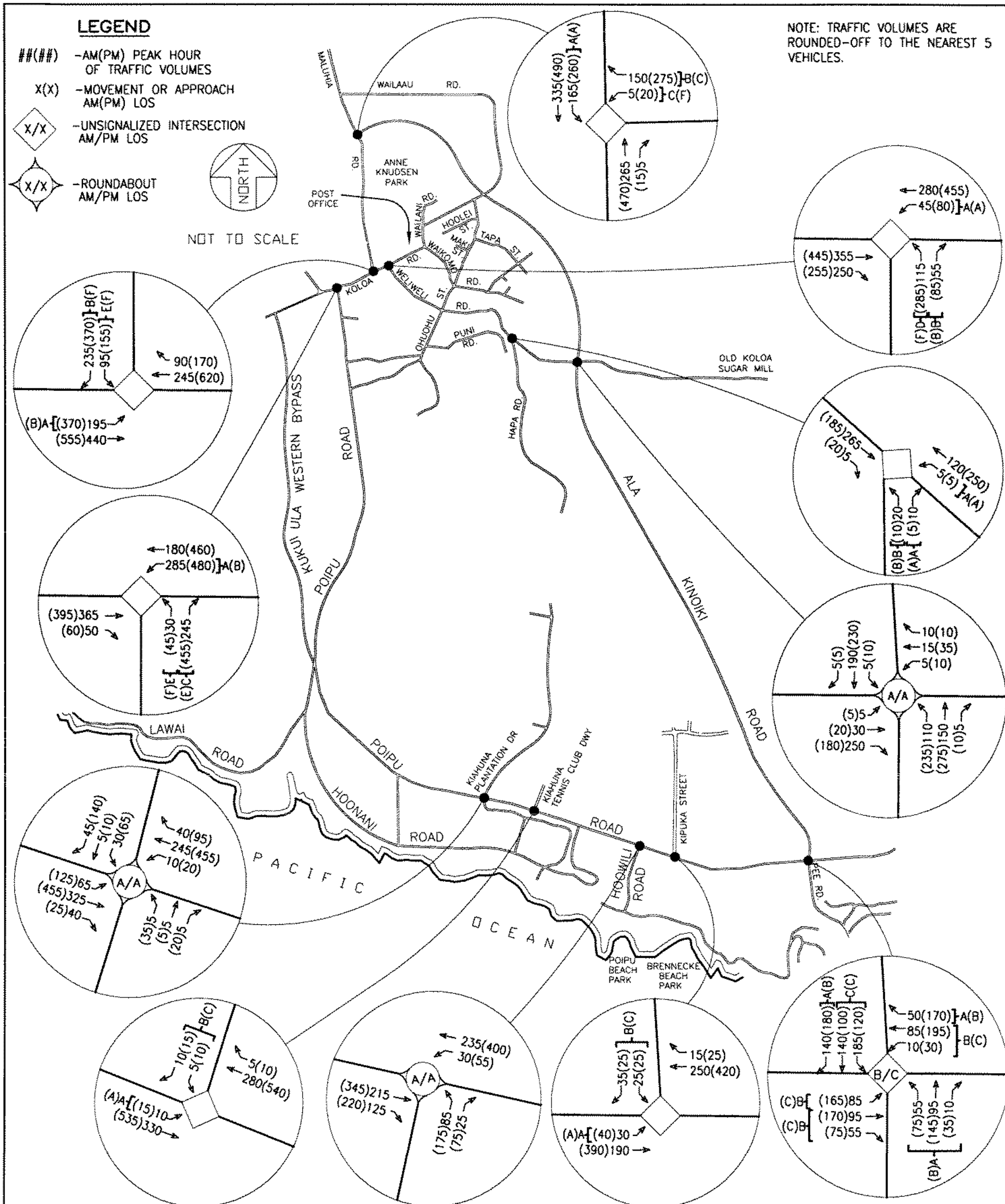
The Poipu Road northbound right-turn traffic will change from LOS E to LOS F and will operate at overcapacity conditions during the PM peak hour of traffic. The Poipu Road northbound left-turn traffic will change from LOS E to LOS F during the AM peak hour of traffic and will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Northbound traffic on Poipu Road will be able to use the Western Bypass as an alternate route to Koloa Road.

Maluhia Road/Ala Kinoiki Road

The Ala Kinoiki Road westbound left-turn traffic will continue to operate at LOS F during the PM peak hour of traffic. Base Year 2015 traffic volumes at the Maluhia Road/Ala Kinioiki Road intersection are not likely to meet the MUTCD traffic signal warrants. It is not uncommon, however, for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway. There are only five (5) and 25 westbound vehicles on Ala Kinoiki Road that are projected to turn left onto Maluhia Road during the AM and PM peak hours of traffic, respectively.

Koloa Road/Weliweli Road

The Weliweli Road northbound left-turn traffic will change from LOS D to LOS E during the AM peak hour of traffic and will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic even if the Weliweli Road northbound approach to Koloa Road is modified to provide an exclusive right-turn lane and an exclusive left-turn lane. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Northbound traffic on Weliweli Road can use Ohuohu Street and Waikomo Road as an alternate route to Koloa Town.



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2005 UPDATE

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BASE YEAR 2010 WITH MITIGATION MEASURES
TRAFFIC VOLUMES AND LOS

FIGURE
7

Table 7
Base Year 2015 Level of Service Summary

	Existing				Base 2010 with Mitigative Measures				Base Year 2015				Base 2015 with Mitigative Measures			
	AM		PM		AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Koloa Road																
NB RT	B	11.1	B	13.3	C	15.3	E	37.3	C	23.4	*F	>50	--	--	--	--
NB LT	C	21.5	*F	>50	E	41.2	*F	>50	F	>50	*F	>50	--	--	--	--
WB LT	A	8.9	A	9.4	A	9.6	B	11.9	B	10.9	C	18.4	--	--	--	--
Koloa Road/Maluhia Road								0								
SB RT	A	9.7	B	13.8	B	12.8	*F	>50	C	16.1	*F	>50	--	--	--	--
SB LT	B	14.5	E	46.2	E	42.1	*F	>50	*F	>50	*F	>50	--	--	--	--
EB LT	A	7.7	A	9.1	A	8.7	B	15	A	9.5	D	31	--	--	--	--
Maluhia Road/Ala Kinoiki Road																
SB LT	A	7.7	A	8.2	A	8.4	A	9.9	A	8.8	B	11.4	--	--	--	--
WB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	--	--	--	--
WB LT	A	0	C	20.2	C	21.9	F	>50	D	29.8	F	>50	--	--	--	--
Koloa Road/Weliweli Road																
NB RT/LT	B	12.2	C	15.3	--	--	--	--	--	--	--	--	--	--	--	--
NB RT	--	--	--	--	B	12.4	B	14.4	B	13.6	C	16.2	--	--	--	--
NB LT	--	--	--	--	D	29.2	*F	>50	E	42.4	*F	>50	--	--	--	--
WB LT	A	8.3	A	8.3	A	9.2	A	9.8	A	9.6	B	10.4	--	--	--	--
Weliweli Road/Hapa Road																
WB LT	A	7.6	A	7.4	A	7.9	A	7.7	A	8	A	7.8	--	--	--	--
NB RT	A	9.3	A	8.8	A	9.9	A	9.4	B	10.3	A	9.6	--	--	--	--
NB LT	A	10	A	10	B	11.6	B	12	B	12.3	B	12.8	--	--	--	--
Ala Kinoiki Road/Weliweli Road																
NB LT	A	7.6	A	7.9	--	--	--	--	--	--	--	--	--	--	--	--
SB LT	A	7.5	A	7.7	--	--	--	--	--	--	--	--	--	--	--	--
WB RT/TH/LT	B	10.5	C	16.3	--	--	--	--	--	--	--	--	--	--	--	--
EB RT/TH/LT	B	10.8	B	11.1	--	--	--	--	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	***A	***3.8	***A	***4.5	***A	***5.1	***A	***4.1	--	--	--	--
Poipu Road/Ala Kinoiki Road/Pee Road																
NB RT/TH/LT	B	12.9	D	26.6	A	9.9	B	12.2	B	10.4	B	13	--	--	--	--
SB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	--	--	--	--
SB TH/LT	B	14.9	C	23.3	C	19.7	C	19.1	D	30.7	D	25.3	--	--	--	--
WB LT/TH	A	7.4	A	7.6	B	11.5	C	18.4	B	13.9	E	38.6	--	--	--	--
WB RT	--	--	--	--	A	9.6	B	13.2	B	10.4	C	15.7	--	--	--	---
EB LT	A	7.4	A	7.9	B	11.6	C	16	B	13.9	C	21.6	--	--	--	--
EB RT/TH	--	--	--	--	B	11.9	C	18.3	C	15.1	D	33.2	--	--	--	--
OVERALL	--	--	--	--	**B	**13.6	**C	**15.9	**C	**18*	**C	**25*	***A*	***5.2*	***A*	***6.6*

* = Volume to Capacity Ratio (v/c) > 1.0

** = All-Way-Stop-Sign Control Configuration

*** = Roundabout Configuration

Note: Delay is in seconds

LOS - Level of Service

Table 7
Base Year 2015 Level of Service Summary

	Existing				Base 2010 with Mitigative Measures				Base Year 2015				Base 2015 with Mitigative Measures			
	AM		PM		AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Kipuka Street																
SB RT/LT	A	9.9	B	11.9	B	11.7	C	17	B	13.8	D	26.9	--	--	--	--
EB LT	A	7.6	A	7.9	A	7.9	A	8.5	A	8.2	A	9.3	--	--	--	--
Poipu Road/Hoowili Road																
NB RT	A	9.3	B	10.2	--	--	--	--	--	--	--	--	--	--	--	--
NB LT	B	11.3	C	17	--	--	--	--	--	--	--	--	--	--	--	--
WB LT	A	7.7	A	8.1	--	--	--	--	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	***A	***3.8	***A	***5.3	***A	***4.5	***A	***8.2	--	--	--	--
Poipu Road/Kiahuna Tennis Club Driveway																
SB RT/LT	A	9.9	B	12.4	B	11.6	C	18	B	13.4	D	31.3	--	--	--	--
EB LT	A	7.6	A	8.1	A	7.9	A	8.8	A	8.2	A	9.7	--	--	--	--
Poipu Road/Kiahuna Plantation Drive																
NB RT/TH/LT	B	11.2	C	23.6	--	--	--	--	--	--	--	--	--	--	--	--
SB RT/TH/LT	B	11.2	C	19.9	--	--	--	--	--	--	--	--	--	--	--	--
WB LT	A	7.7	A	9.1	--	--	--	--	--	--	--	--	--	--	--	--
EB LT	A	7.6	A	8.3	--	--	--	--	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	****A*	****4.0*	****A*	****5.6*	****A*	****4.7*	****A*	****9.9*	--	--	--	--

* = Volume to Capacity Ratio (v/c) > 1.0
** = All-Way-Stop-Sign Control Configuration
Note: Delay is in seconds
LOS - Level of Service

*** = Roundabout Configuration

Poipu Road/Ala Kinoiki Road Road/Pee Road

Should an AWSC intersection be implemented in lieu of a single-lane roundabout, the Poipu Road westbound shared through/left-turn traffic will change from LOS C to LOS E during the PM peak hour of traffic. Base Year 2015 traffic volumes at this intersection are not likely to meet the MUTCD traffic signal warrants.

2. Base Year 2015 Traffic Mitigation Measures

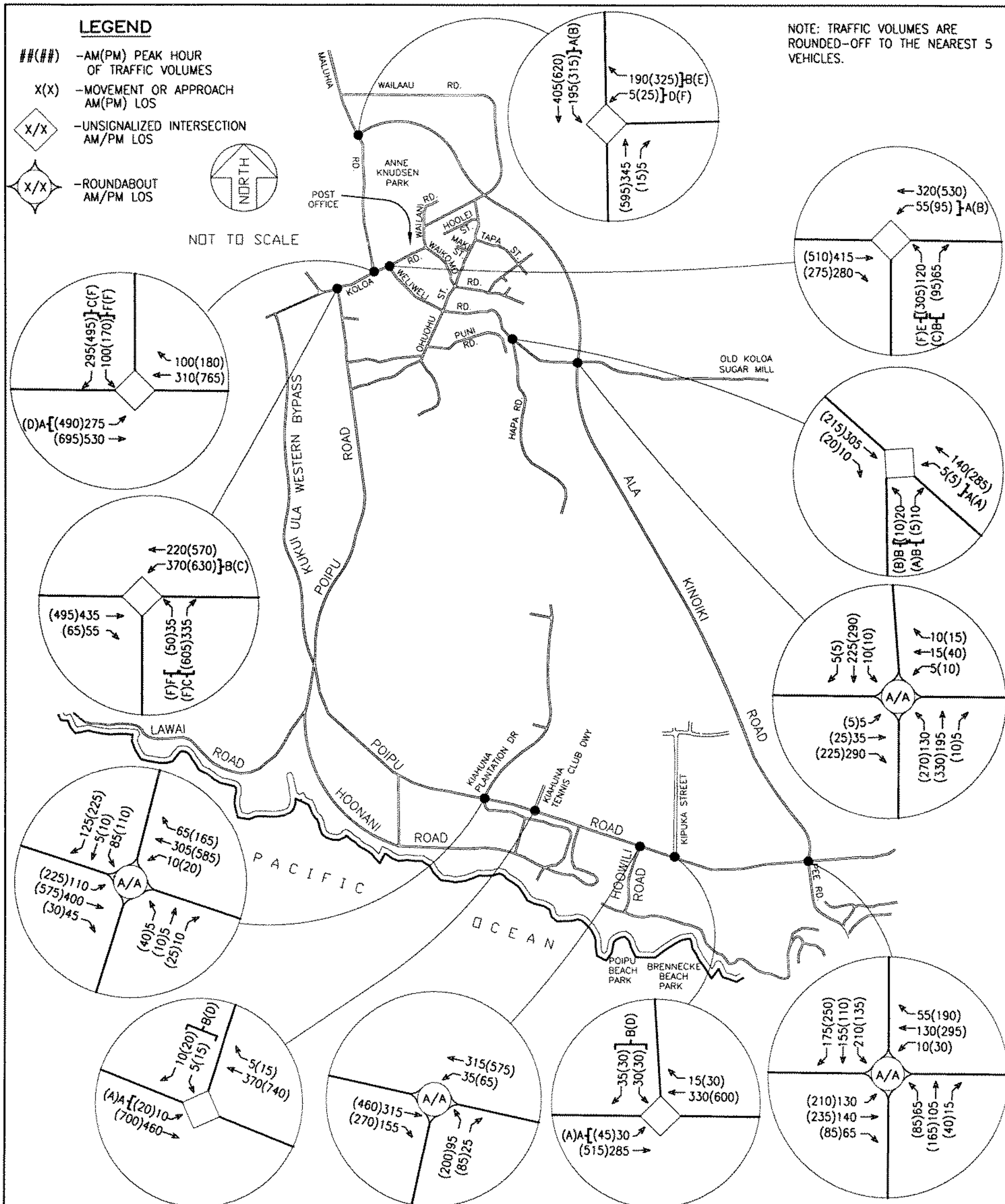
Poipu Road/Ala Kinoiki Road Road/Pee Road

Should a single-lane roundabout be constructed as previously discussed for Base Year 2006, traffic at this intersection will operate overall at LOS A during the AM and PM peak hours of traffic.

Poipu Road/Kiahuna Plantation Drive

The westbound Poipu Road approach, which is currently served by a shared right-turn/through lane and an exclusive left-turn lane, will require an exclusive right-turn lane, a through lane and an exclusive left-turn lane even with a traffic signal installed at this intersection. With the installation of a traffic signal and laneage modification as previously described, the Poipu Road/Kiahuna Plantation Drive intersection will operate overall at LOS B during the AM peak hour of traffic and LOS D during the PM peak hour of traffic. All individual movements will operate at LOS C or better during the AM peak hour of traffic and LOS D or better during the PM peak hour of traffic. Should a single-lane roundabout be constructed as previously discussed for Base Year 2010, traffic at this intersection will operate overall at LOS A during the AM and PM peak hours of traffic.

Figure 8 shows the traffic volumes and LOS for Base Year 2015 with mitigation measures.



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VILLAGE AT POIPU
2005 UPDATE

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BASE YEAR 2015 WITH MITIGATION MEASURES
TRAFFIC VOLUMES AND LOS

FIGURE
8

IV. FUTURE TRAFFIC CONDITIONS WITH THE PROJECT

A. Trip Generation

Trip generation estimates the total number of vehicular trips produced by a given land use. Trip rates contained in the nationally published ITE Trip Generation, 7th Edition, were used to estimate the number of trips generated by the Project. Table 8 shows the trip generation rates used for the proposed development. Table 9 shows the peak hour trips generated by each development phase of the Project.

Table 8

Trip Generation Rates for Project

Land Use (ITE Code)	Independent Variable	Daily Trip Rate	AM Peak Hour of Traffic		PM Peak Hour of Traffic	
			Trip Rate	% Enter	Trip Rate	% Enter
Single-Family Home (210)	DU	a	b	25%	c	63%
Multi-Family Home (230)	DU	d	e	17%	f	67%
Recreational Home (260)	DU	3.16	0.16	67%	0.26	41%
Community Park (412)	AC	2.28	0.01	80%	0.06	41%

T= number of trips ends	a	$Ln(T)= 0.92*Ln(X)+2.71$
X= independent variable	b	$T= 0.70*X+9.43$
DU= dwelling units	c	$Ln(T)= 0.90*Ln(X)+0.53$
AC= acres	d	$Ln(T)= 0.85*Ln(X)+2.55$
	e	$Ln(T)= 0.80*Ln(X)+0.26$
	f	$Ln(T)= 0.82*Ln(X)+0.32$

Table 9

Project Land Uses and Trip Generation

		Average Daily	AM Peak Hour of Traffic		PM Peak Hour of Traffic	
Land-Use Designation	**No. of Units**	**Trips (vpd)**	**Enter (vph)**	**Exit (vph)**	**Enter (vph)**	**Exit (vph)**
Phase 1						
Single-Family Home	25 DU	290	7	20	20	11
Recreational Home	25 DU	79	3	1	3	4
Community Park	2.5 AC	6	1	1	1	1
Subtotal – Phase 1	-	***375***	***11***	***22***	***24***	***16***
Phase 2						
Single-Family Home	44 DU	489	10	30	32	19
Multi-Family Home	67 DU	457	6	31	29	14
Recreational Home	110 DU	348	12	6	12	17
Community Park	6.0 AC	14	1	1	1	1
Subtotal – Phase 2	-	***1,308***	***29***	***68***	***74***	***51***
Phase 3						
Single-Family Home	116 DU	1,192	23	68	77	46
Recreational Home	116 DU	367	13	6	12	18
Community Park	3.5 AC	8	1	1	1	1
Subtotal – Phase 3	-	***1,567***	***37***	***75***	***90***	***65***
Total Phases 1 through 3	-	**3,250**	**77**	**165**	**188**	**132**

vpd = vehicles per day

vph = vehicles per hour

DU = dwelling units

AC = acres

B. Trip Distribution

Trip distribution identifies the direction of travel of trips to and from the project site by determining the likely external origins and destinations of the project-generated trips. The project-generated traffic was distributed onto the roadway network based on the trip distribution factors derived from field observations and existing traffic count data and are shown in Table 10.

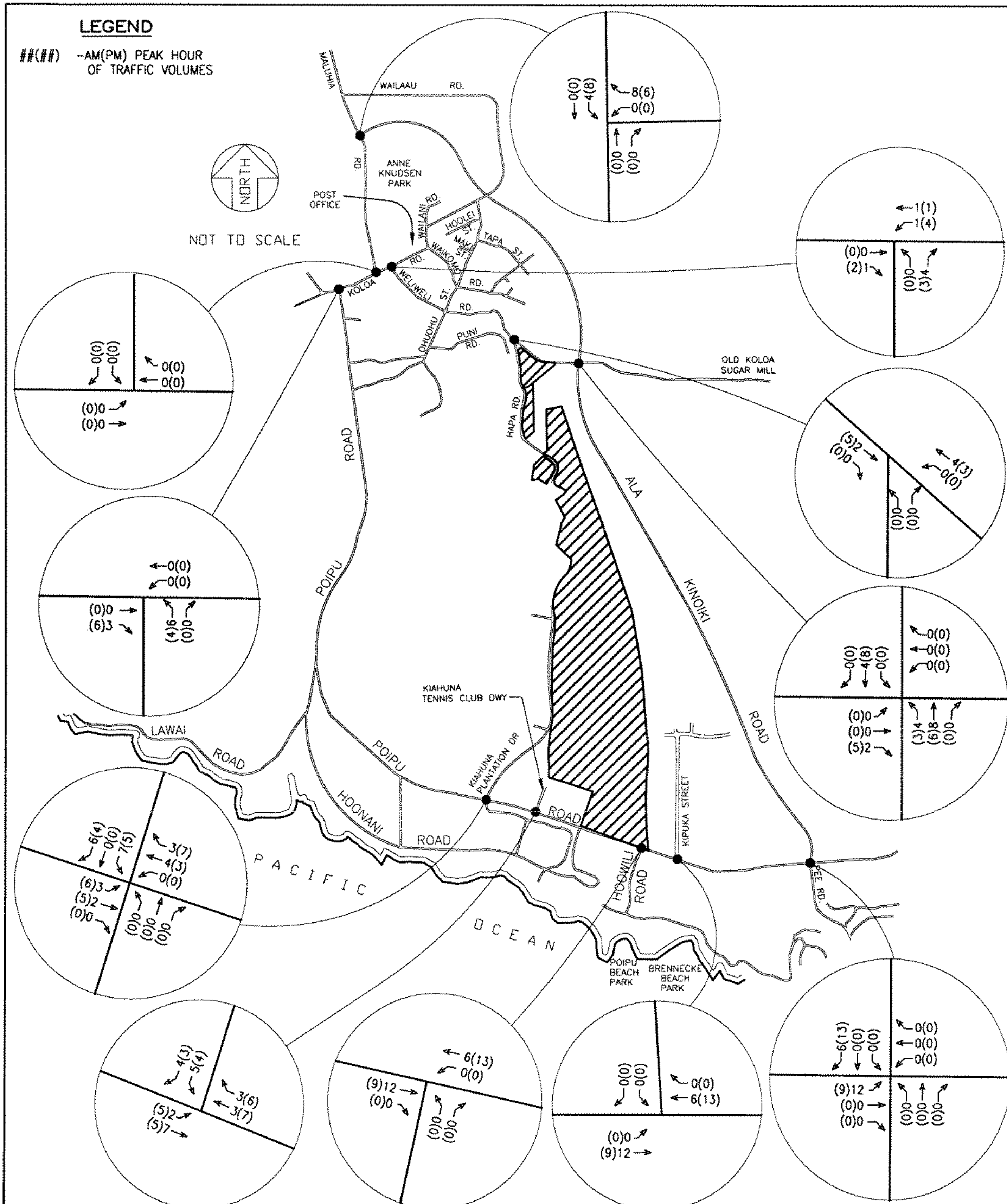
Table 10
Trip Distribution Factors

Direction (to/from)	Factor
Lihue	35%
Koloa	20%
Poipu	20%
Waimea	25%
Total	**100%**

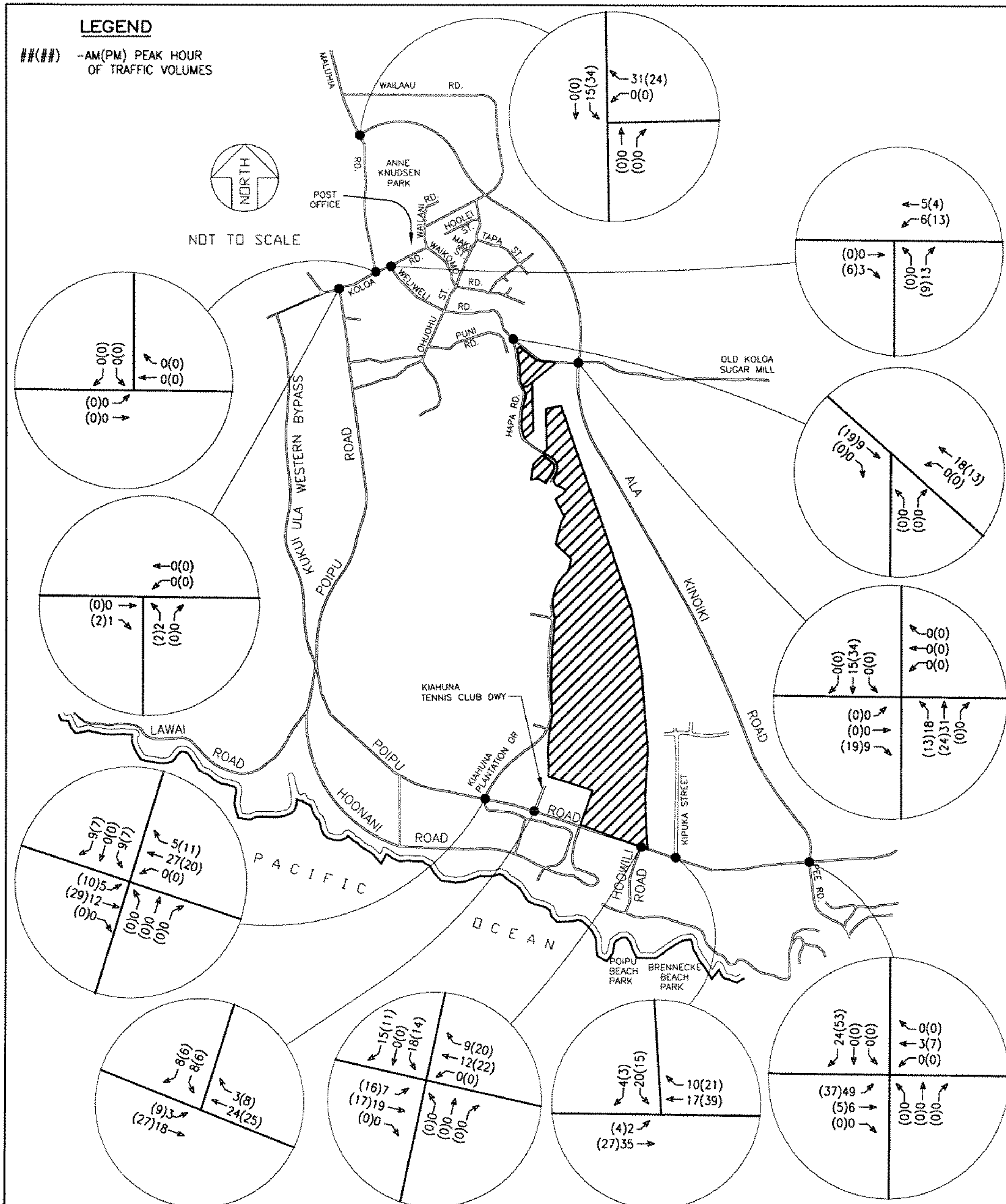
C. Traffic Assignment

The traffic assignment determines the routes traveled by Project-generated traffic. Year 2006 Project-generated traffic was assigned to the existing Kiahuna Plantation Drive and existing Kiahuna Tennis Club Driveway. Year 2010 Project-generated traffic was assigned to the access points used for Year 2006 Project-generated traffic, along with Driveway A to be constructed from Poipu Road across from Hoowili Road, and the existing Kipuka Street which will be connected to the Project via an extension of the existing Pahoehoe Street. Year 2015 Project-generated traffic was assigned to all five access points, which consist of the access points used for Year 2010 Project-generated traffic and the existing northern portion of Hapa Road. Figures 9, 10 and 11 show the Project-generated traffic assignment for the Years 2006, 2010 and 2015, respectively.

Project-generated trips were added to Base Year 2006, 2010 and 2015 traffic projections to estimate Year 2006, 2010 and 2015 traffic conditions with the Project.



ERIC KNUDSEN TRUST VILLAGE AT POIPU 2005 UPDATE	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS, SURVEYORS • HONOLULU, HAWAII PHASE 1 PROJECT-GENERATED TRAFFIC	FIGURE 9



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2005 UPDATE

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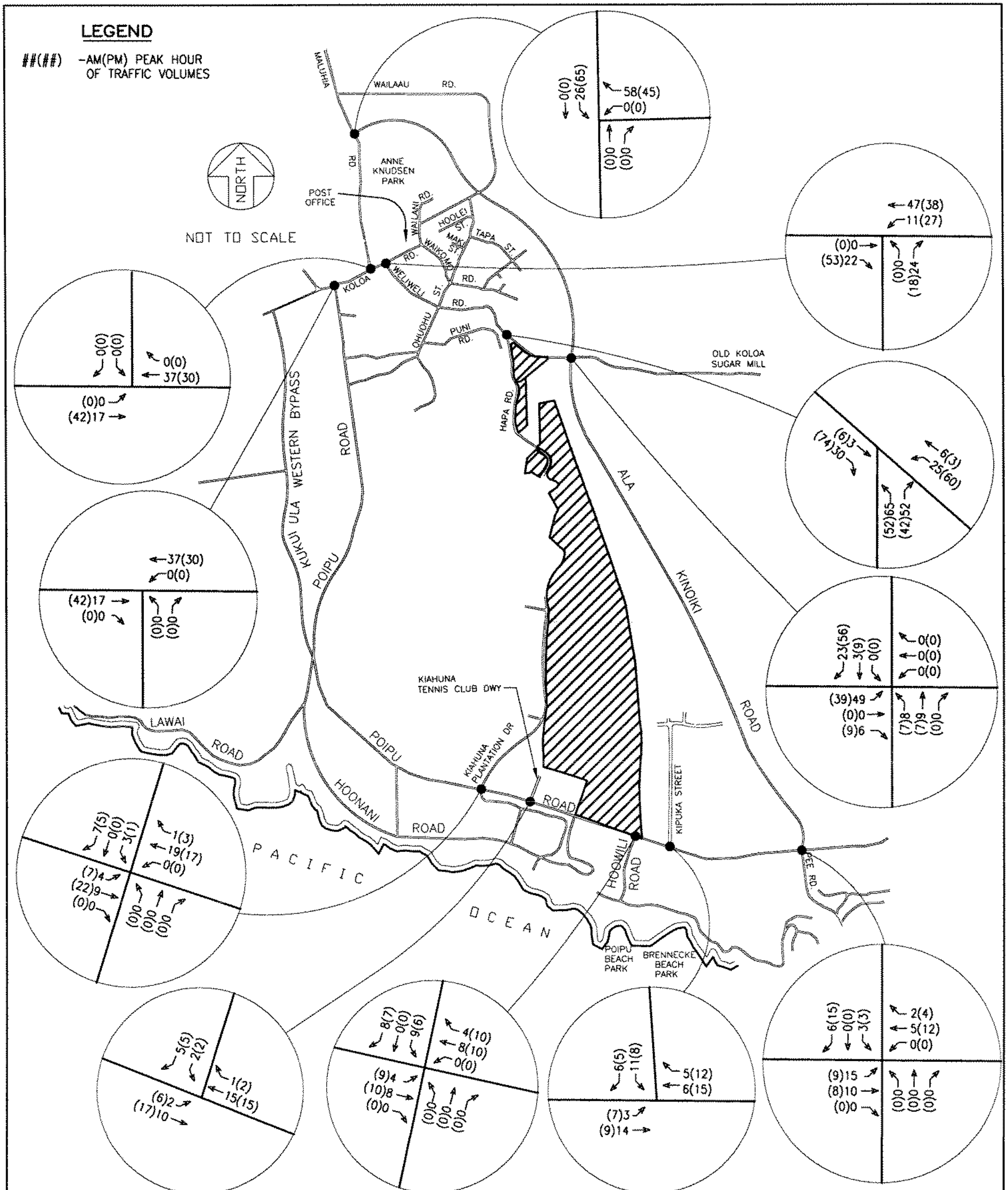
PHASES 1 AND 2 PROJECT-GENERATED TRAFFIC

FIGURE
10



ERIC KNUDSEN TRUST VILLAGE AT POIPU 2005 UPDATE	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS, SURVEYORS • HONOLULU, HAWAII	FIGURE
	PHASES 1, 2 AND 3 PROJECT-GENERATED TRAFFIC	11

D. Year 2006 Conditions With the Project

As mentioned earlier, Year 2006 Project-generated traffic will utilize Kiahuna Plantation Drive and the Kiahuna Tennis Club Driveway, as the other access points will not be constructed by Year 2006.

The results of the intersection analyses for Year 2006 with the Project traffic are summarized and compared to Base Year 2006 conditions in Table 11. Figure 12 shows the traffic volumes and LOS for Year 2006 with the Project. The following are individual turning movements or intersections that will operate at LOS E or LOS F conditions.

Koloa Road/Maluhia Road

The Maluhia Road southbound left-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Poipu Road intersection. Southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Koloa Road/Poipu Road

The Poipu Road northbound left-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection.

E. Year 2010 Conditions With the Project

As mentioned earlier, Year 2010 Project-generated traffic will utilize Kiahuna Plantation Drive, the Kiahuna Tennis Club Driveway, Driveway A and Kipuka Street. The Poipu Road/Hoowili Road/Driveway A intersection was assumed to have the following laneage should a traffic signal be installed at this intersection:

- an exclusive right-turn lane and a shared through/left-turn lane on the northbound Hoowili Road approach,

- a shared right-turn/through/left-turn lane on the southbound Driveway A approach,
- a shared right-turn/through lane and an exclusive left-turn lane on the westbound and eastbound Poipu Road approaches.

Although an exclusive left-turn lane is not required for eastbound traffic entering the Project per criteria presented in the HCM 2000, an exclusive eastbound left-turn lane was assumed since there is an existing exclusive westbound left-turn lane on the opposite side of the intersection. With the installation of a traffic signal and laneage as previously described, the Poipu Road/Hoowili Road/Driveway A intersection will operate overall at LOS A during the AM peak hour of traffic and LOS B during the PM peak hour of traffic. All individual movements will operate at LOS B or better during the AM and PM peak hours of traffic. Should a single-lane roundabout be constructed as previously discussed for Base Year 2010, traffic at this intersection will operate overall at LOS A during the AM and PM peak hours of traffic.

The results of the intersection analyses for Year 2010 with the Project traffic are summarized and compared to Base Year 2010 conditions in Table 12. Figure 13 shows the traffic volumes and LOS for Year 2010 with the Project. The following are individual turning movements or intersections that will operate at LOS E or LOS F conditions.

Koloa Road/Maluhia Road

The Maluhia Road southbound right-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. The Maluhia Road southbound left-turn traffic will change from LOS E to LOS F during the AM peak hour of traffic, and will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Poipu Road intersection. Southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Table 11
Year 2006 with Phase 1 Project Generated Traffic
Level of Service Summary

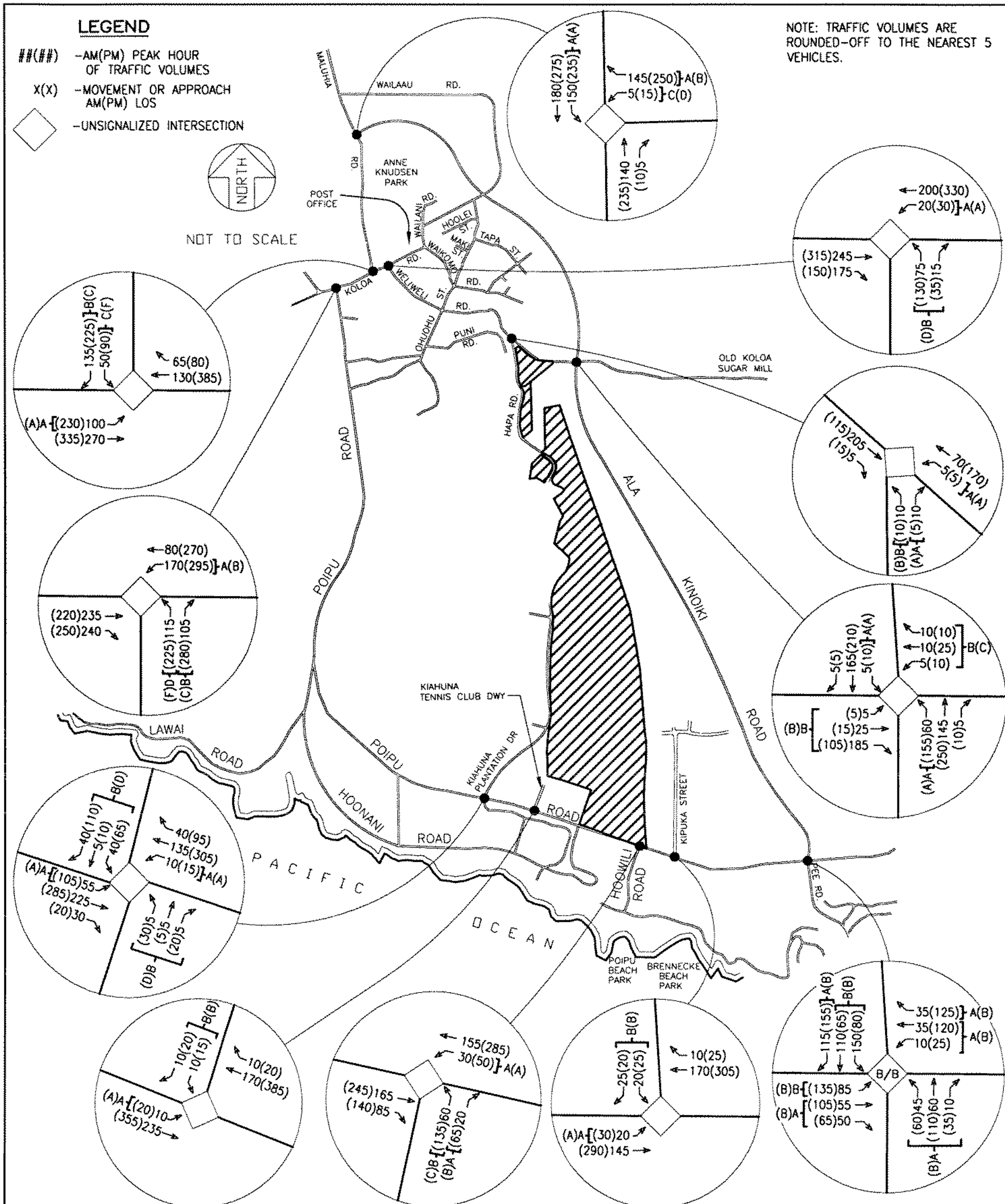
	Existing				Base 2006 with Mitigative Measures				Future 2006			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Koloa Road												
NB RT	B	11.1	B	13.3	B	11.7	B	15	B	11.7	C	15.2
NB LT	C	21.5	*F	>50	D	27	*F	>50	D	30.6	*F	>50
WB LT	A	8.9	A	9.4	A	9.2	A	10	A	9.3	B	10.1
Koloa Road/Maluhia Road												
SB RT	A	9.7	B	13.8	B	10.1	C	15.5	B	10.1	C	15.5
SB LT	B	14.5	E	46.2	C	16.5	F	>50	C	16.5	*F	>50
EB LT	A	7.7	A	9.1	A	7.9	A	9.6	A	7.9	A	9.6
Maluhia Road/Ala Kinoiki Road												
SB LT	A	7.7	A	8.2	A	7.9	A	8.5	A	7.9	A	8.5
WB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--
WB LT	A	0	C	20.2	B	14.9	C	25	C	15.1	D	25.9
Koloa Road/Weliweli Road												
NB RT/LT	B	12.2	C	15.3	B	14.7	C	24.9	B	15	D	26.2
WB LT	A	8.3	A	8.3	A	8.3	A	8.5	A	8.4	A	8.6
Weliweli Road/Hapa Road												
WB LT	A	7.6	A	7.4	A	7.7	A	7.5	A	7.7	A	7.5
NB RT	A	9.3	A	8.8	A	9.5	A	9	A	9.5	A	9
NB LT	A	10	A	10	B	10.4	B	10.5	B	10.4	B	10.6
Ala Kinoiki Road/Weliweli Road												
NB LT	A	7.6	A	7.9	A	7.7	A	8.1	A	7.7	A	8.1
SB LT	A	7.5	A	7.7	A	7.5	A	7.8	A	7.6	A	7.9
WB RT/TH/LT	B	10.5	C	16.3	B	12.6	C	21.1	B	13	C	22.3
EB RT/TH/LT	B	10.8	B	11.1	B	11.8	B	13.1	B	12	B	13.4
Poipu Road/Ala Kinoiki Road/Pee Road												
NB RT/TH/LT	B	12.9	D	26.6	A	9.2	B	10.8	A	9.2	B	10.8
SB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--
SB TH/LT	B	14.9	C	23.3	B	13.5	B	12.8	B	13.6	B	12.9
WB LT/TH	A	7.4	A	7.6	A	9.7	B	12.4	A	9.8	B	12.5
EB LT	A	7.4	A	7.9	B	10.4	B	12.5	B	10.7	B	12.9
EB RT/TH	--	--	--	--	A	9.8	B	12.1	A	9.8	B	12.2
OVERALL	--	--	--	--	**B	**10.8	**B	**11.6	**B	**10.9	**B	**11.8

* = Volume to Capacity Ratio (v/c) > 1.0
** = All-Way-Stop-Sign Control Configuration
Note: Delay is in seconds
LOS - Level of Service

Table 11
Year 2006 with Phase 1 Project Generated Traffic
Level of Service Summary

	Existing				Base 2006 with Mitigative Measures				Future 2006			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Kipuka Street												
SB RT/LT	A	9.9	B	11.9	B	10.3	B	13.3	B	10.4	B	13.7
EB LT	A	7.6	A	7.9	A	7.7	A	8.1	A	7.7	A	8.1
Poipu Road/Hoowili Road/Driveway A												
NB RT	A	9.3	B	10.2	A	9.5	B	10.7	A	9.6	B	10.8
NB LT	B	11.3	C	17	B	12.4	C	22	B	12.7	C	23.2
WB LT	A	7.7	A	8.1	A	7.8	A	8.3	A	7.9	A	8.4
Poipu Road/Kiahuna Tennis Club Driveway												
SB RT/LT	A	9.9	B	12.4	B	10.4	B	13.3	B	10.7	B	14.2
EB LT	A	7.6	A	8.1	A	7.6	A	8.2	A	7.7	A	8.3
Poipu Road/Kiahuna Plantation Drive												
NB RT/TH/LT	B	11.2	C	23.6	B	12.9	D	26.3	B	13.3	D	28.8
SB RT/TH/LT	B	11.2	C	19.9	B	12.6	D	27	B	13.3	D	31.6
WB LT	A	7.7	A	9.1	A	7.8	A	8	A	7.9	A	8
EB LT	A	7.6	A	8.3	A	7.7	A	8.5	A	7.7	A	8.6

* = Volume to Capacity Ratio (v/c) > 1.0
** = All-Way-Stop-Sign Control Configuration
Note: Delay is in seconds
LOS - Level of Service



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YEAR 2006 WITH PROJECT-GENERATED TRAFFIC VOLUMES AND LOS

FIGURE 12

Table 12
Year 2010 with Phases 1 and 2 Project Generated Traffic
Level of Service Summary

	Existing				Base 2010 with Mitigative Measures				Future 2010			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Koloa Road												
NB RT	B	11.1	B	13.3	C	15.3	E	37.3	C	15.3	E	37.8
NB LT	C	21.5	*F	>50	E	41.2	*F	>50	E	43.7	*F	>50
WB LT	A	8.9	A	9.4	A	9.6	B	11.9	A	9.7	B	11.9
Koloa Road/Maluhia Road												
SB RT	A	9.7	B	13.8	B	12.8	*F	>50	B	12.9	*F	>50
SB LT	B	14.5	E	46.2	E	42.1	*F	>50	F	>50	*F	>50
EB LT	A	7.7	A	9.1	A	8.7	B	15	A	8.7	B	15
Maluhia Road/Ala Kinoiki Road												
SB LT	A	7.7	A	8.2	A	8.4	A	9.9	A	8.4	B	10.2
WB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--
WB LT	A	0	C	20.2	C	21.9	F	>50	C	23	F	>50
Koloa Road/Weliweli Road												
NB RT/LT	B	12.2	C	15.3	--	--	--	--	--	--	--	--
NB RT	--	--	--	--	B	12.4	B	14.4	B	12.7	B	14.8
NB LT	--	--	--	--	D	29.2	*F	>50	D	31.7	*F	>50
WB LT	A	8.3	A	8.3	A	9.2	A	9.8	A	9.2	A	10
Weliweli Road/Hapa Road												
WB LT	A	7.6	A	7.4	A	7.9	A	7.7	A	7.9	A	7.8
NB RT	A	9.3	A	8.8	A	9.9	A	9.4	A	10	A	9.5
NB LT	A	10	A	10	B	11.6	B	12	B	11.9	B	12.4
Ala Kinoiki Road/Weliweli Road												
NB LT	A	7.6	A	7.9	--	--	--	--	--	--	--	--
SB LT	A	7.5	A	7.7	--	--	--	--	--	--	--	--
WB RT/TH/LT	B	10.5	C	16.3	--	--	--	--	--	--	--	--
EB RT/TH/LT	B	10.8	B	11.1	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	***A	***3.8	***A	***4.5	***A	***3.9	***A	***4.8
Poipu Road/Ala Kinoiki Road/Pee Road												
NB RT/TH/LT	B	12.9	D	26.6	A	9.9	B	12.2	A	9.8	B	12.1
SB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--
SB TH/LT	B	14.9	C	23.3	C	19.7	C	19.1	C	21.2	C	19.7
WB LT/TH	A	7.4	A	7.6	B	11.5	C	18.4	B	11.9	C	20.2
WB RT	--	--	--	--	A	9.6	B	13.2	A	9.8	B	13.7
EB LT	A	7.4	A	7.9	B	11.6	C	16	B	13.2	C	19.1
EB RT/TH	--	--	--	--	B	11.9	C	18.3	B	12.4	C	19.5
OVERALL	--	--	--	--	**B	**13.6	**C	**15.9	***B*	***14.3*	***C*	***17.3*

* = Volume to Capacity Ratio (v/c) > 1.0

** = All-Way-Stop-Sign Control Configuration

Note: Delay is in seconds

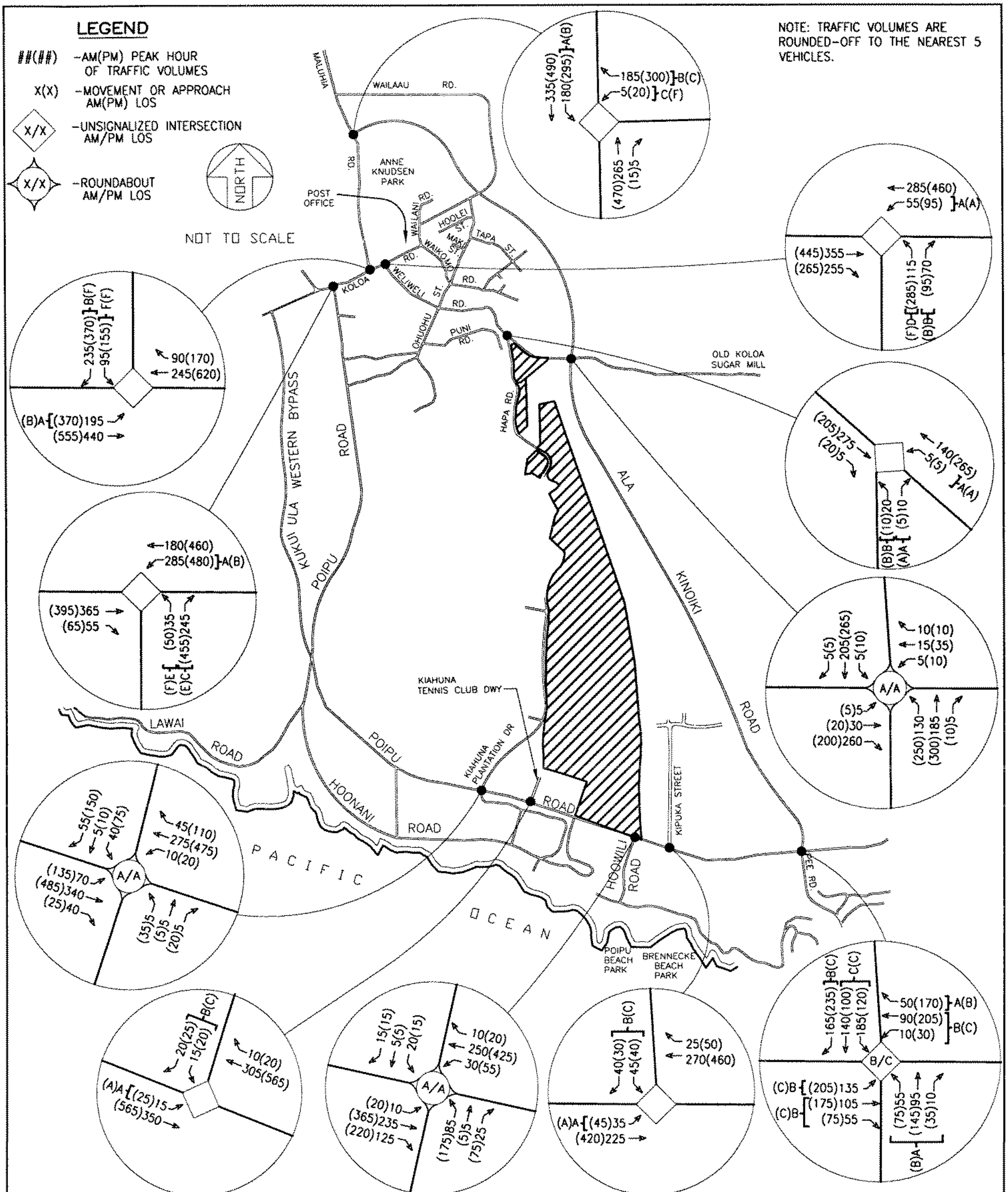
LOS - Level of Service

Table 12
Year 2010 with Phases 1 and 2 Project Generated Traffic
Level of Service Summary

	Existing				Base 2010 with Mitigative Measures				Future 2010			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Kipuka Street												
SB RT/LT	A	9.9	B	11.9	B	11.7	C	17	B	13.3	C	21.4
EB LT	A	7.6	A	7.9	A	7.9	A	8.5	A	8	A	8.8
Poipu Road/Hoowili Road/Driveway A												
NB RT	A	9.3	B	10.2	--	--	--	--	--	--	--	--
NB RT/TH	--	--	--	--	--	--	--	--	--	--	--	--
NB LT	B	11.3	C	17	--	--	--	--	--	--	--	--
SB RT/TH/LT	--	--	--	--	--	--	--	--	--	--	--	--
WB LT	A	7.7	A	8.1	--	--	--	--	--	--	--	--
EB LT	--	--	--	--	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	***A	***3.8	***A	***5.3	***A	***3.9	***A	***5.5
Poipu Road/Kiahuna Tennis Club Driveway												
SB RT/LT	A	9.9	B	12.4	B	11.6	C	18	B	12.8	C	22
EB LT	A	7.6	A	8.1	A	7.9	A	8.8	A	8	A	9
Poipu Road/Kiahuna Plantation Drive												
NB RT/TH/LT	B	11.2	C	23.6	--	--	--	--	--	--	--	--
SB RT/TH/LT	B	11.2	C	19.9	--	--	--	--	--	--	--	--
WB LT	A	7.7	A	9.1	--	--	--	--	--	--	--	--
EB LT	A	7.6	A	8.3	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	****A*	****4.0*	****A*	****5.6*	****A*	****4.1*	****A*	****6.0*

* = Volume to Capacity Ratio (v/c) > 1.0
** = All-Way-Stop-Sign Control Configuration
Note: Delay is in seconds
LOS - Level of Service

*** = Roundabout Configuration



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YEAR 2010 WITH PROJECT-GENERATED TRAFFIC VOLUMES AND LOS

FIGURE

13

Koloa Road/Poipu Road

The Poipu Road northbound right-turn traffic will continue to operate at LOS E during the PM peak hour of traffic. The Poipu Road northbound left-turn traffic will continue to operate at LOS E during the AM peak hour of traffic, and LOS F at overcapacity conditions during the PM peak hour of traffic. As previously mentioned, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Northbound traffic on Poipu Road will be able to use the Western Bypass as an alternate route to Koloa Road.

Maluhia Road/Ala Kinoiki Road

The Ala Kinoiki Road westbound left-turn traffic will continue to operate at LOS F during the PM peak hour of traffic. Year 2010 traffic volumes with the Project are not likely to meet MUTCD traffic signal warrants at the Maluhia Road/Ala Kinioiki Road intersection. It is not uncommon, however, for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway. Project-generated traffic is not expected to increase the number of vehicles on Ala Kinoiki Road that turn left onto Maluhia Road.

Koloa Road/Weliweli Road

The Weliweli Road northbound left-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic even if the Weliweli Road northbound approach to Koloa Road is modified to provide an exclusive right-turn lane and an exclusive left-turn lane. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Northbound traffic on Weliweli Road can use Ohuohu Street and Waikomo Road as an alternate route to Koloa Town.

F. Year 2015 Conditions With the Project

As mentioned earlier, Year 2015 Project-generated traffic will utilize all five access points (Kiahuna Plantation Drive, the Kiahuna Tennis Club Driveway, Driveway A, Kipuka Street and Hapa Road).

The results of the intersection analysis for Year 2015 with the Project traffic are summarized and compared to Base Year 2015 conditions in Table 13. Figure 14 shows the traffic volumes and LOS for Year 2015 with the Project. The following are individual turning movements or intersections that will operate at LOS E or LOS F conditions.

Koloa Road/Maluhia Road

The Maluhia Road southbound right-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. The Maluhia Road southbound left-turn traffic will continue to operate at LOS F at overcapacity conditions during the AM and PM peak hours of traffic. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Poipu Road intersection. Southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Koloa Road/Poipu Road

The Poipu Road northbound right-turn traffic will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic. The Poipu Road northbound left-turn traffic will continue to operate at LOS F at overcapacity conditions during the AM and PM peak hours of traffic. As previously mentioned, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Northbound traffic on Poipu Road will be able to use the Western Bypass as an alternate route to Koloa Road.

Table 13
Year 2015 with Phases 1, 2, and 3 Project Generated Traffic
Level of Service Summary

	Existing				Base 2015 with Mitigative Measures				Future 2015			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Koloa Road												
NB RT	B	11.1	B	13.3	C	23.4	*F	>50	C	24.9	*F	>50
NB LT	C	21.5	*F	>50	F	>50	*F	>50	F	>50	*F	>50
WB LT	A	8.9	A	9.4	B	10.9	C	18.4	B	11.1	C	20.6
Koloa Road/Maluhia Road												
SB RT	A	9.7	B	13.8	C	16.1	*F	>50	C	17.5	*F	>50
SB LT	B	14.5	E	46.2	*F	>50	*F	>50	*F	>50	*F	>50
EB LT	A	7.7	A	9.1	A	9.5	D	31	A	9.8	D	34.3
Maluhia Road/Ala Kinoiki Road												
SB LT	A	7.7	A	8.2	A	8.8	B	11.4	A	8.9	B	12.3
WB RT	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--	FREE	--
WB LT	A	0	C	20.2	D	29.8	F	>50	D	33.4	*F	>50
Koloa Road/Weliweli Road												
NB RT/LT	B	12.2	C	15.3	--	--	--	--	--	--	--	--
NB RT	--	--	--	--	B	13.6	C	16.2	B	14.5	C	17.7
NB LT	--	--	--	--	E	42.4	*F	>50	F	>50	*F	>50
WB LT	A	8.3	A	8.3	A	9.6	B	10.4	A	9.9	B	11.1
Weliweli Road/Hapa Road												
WB LT	A	7.6	A	7.4	A	8	A	7.8	A	8.2	A	8.2
NB RT	A	9.3	A	8.8	B	10.3	A	9.6	B	11	B	10.3
NB LT	A	10	A	10	B	12.3	B	12.8	B	14.9	C	18.1
Ala Kinoiki Road/Weliweli Road												
NB LT	A	7.6	A	7.9	--	--	--	--	--	--	--	--
NB RT/TH	--	--	--	--	--	--	--	--	--	--	--	--
SB LT	A	7.5	A	7.7	--	--	--	--	--	--	--	--
SB RT/TH	--	--	--	--	--	--	--	--	--	--	--	--
WB RT/TH/LT	B	10.5	C	16.3	--	--	--	--	--	--	--	--
EB RT/TH/LT	B	10.8	B	11.1	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	***A	***5.1	***A	***4.1	***A	***5.5	***A	***4.4
Poipu Road/Ala Kinoiki Road/Pee Road												
NB RT/TH/LT	B	12.9	D	26.6	--	--	--	--	--	--	--	--
SB RT	FREE	--	FREE	--	--	--	--	--	--	--	--	--
SB TH/LT	B	14.9	C	23.3	--	--	--	--	--	--	--	--
WB LT/TH	A	7.4	A	7.6	--	--	--	--	--	--	--	--
WB RT	--	--	--	--	--	--	--	---	--	--	--	--
EB LT	A	7.4	A	7.9	--	--	--	--	--	--	--	--
EB RT/TH	--	--	--	--	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	***A	***5.2	***A	***6.6	***A	***5.4	***A	***7.0

* = Volume to Capacity Ratio (v/c) > 1.0

*** = Roundabout Configuration

Note: Delay is in seconds
LOS - Level of Service

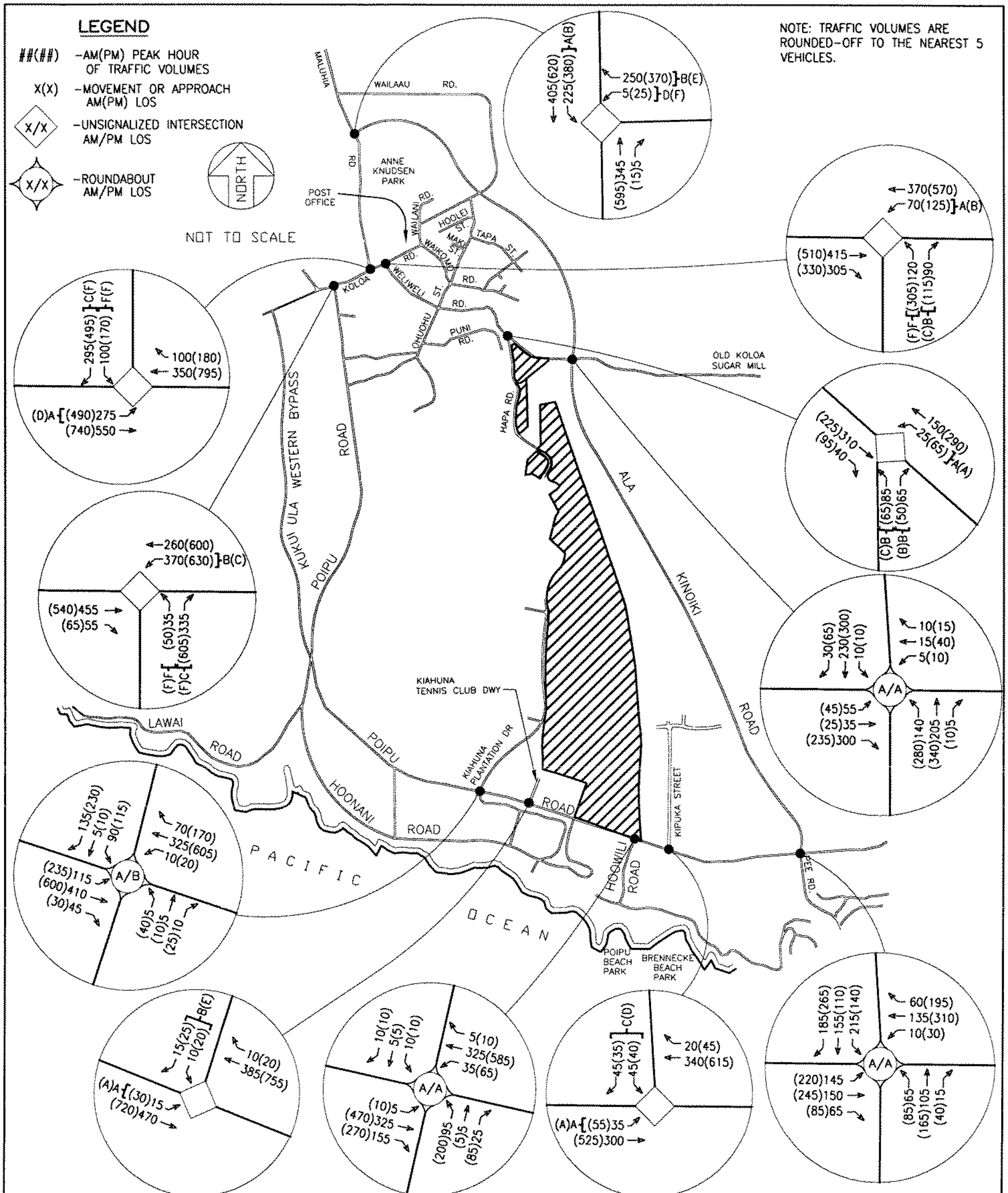
Table 13
Year 2015 with Phases 1, 2, and 3 Project Generated Traffic
Level of Service Summary

	Existing				Base 2015 with Mitigative Measures				Future 2015			
	AM		PM		AM		PM		AM		PM	
Intersection	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)	LOS	Delay(s)
Poipu Road/Kipuka Street												
SB RT/LT	A	9.9	B	11.9	B	13.8	D	26.9	C	15.3	D	33.9
EB LT	A	7.6	A	7.9	A	8.2	A	9.3	A	8.2	A	9.5
Poipu Road/Hoowili Road/Driveway A												
NB RT	A	9.3	B	10.2	--	--	--	--	--	--	--	--
NB LT	B	11.3	C	17	--	--	--	--	--	--	--	--
WB LT	A	7.7	A	8.1	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	--	--	--	--	***A	***4.4	***A	***7.6
Poipu Road/Kiahuna Tennis Club Driveway												
SB RT/LT	A	9.9	B	12.4	B	13.4	D	31.3	B	14.4	E	37.3
EB LT	A	7.6	A	8.1	A	8.2	A	9.7	A	8.3	A	9.8
Poipu Road/Kiahuna Plantation Drive												
NB RT/TH/LT	B	11.2	C	23.6	--	--	--	--	--	--	--	--
SB RT/TH/LT	B	11.2	C	19.9	--	--	--	--	--	--	--	--
WB LT	A	7.7	A	9.1	--	--	--	--	--	--	--	--
EB LT	A	7.6	A	8.3	--	--	--	--	--	--	--	--
OVERALL	--	--	--	--	***A	***4.7	***A	***9.9	***A	***4.9	***B	***11.1

* = Volume to Capacity Ratio (v/c) > 1.0

*** = Roundabout Configuration

Note: Delay is in seconds
LOS - Level of Service



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YEAR 2015 WITH PROJECT-GENERATED TRAFFIC VOLUMES AND LOS

FIGURE 14

Maluhia Road/Ala Kinoiki Road

The Ala Kinoiki Road westbound left-turn traffic will continue to operate at LOS F during the PM peak hour of traffic, and will operate at overcapacity conditions during the PM peak hour of traffic. Year 2015 traffic volumes with the Project are not likely to meet MUTCD traffic signal warrants at the Maluhia Road/Ala Kinioiki Road intersection. It is not uncommon, however, for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway. Project-generated traffic is not expected to increase the number of vehicles on Ala Kinoiki Road that turn left onto Maluhia Road.

Koloa Road/Weliweli Road

The Weliweli Road northbound left-turn traffic will change from LOS E to LOS F during the AM peak hour of traffic, and will continue to operate at LOS F at overcapacity conditions during the PM peak hour of traffic even if the Weliweli Road northbound approach to Koloa Road is modified to provide an exclusive right-turn lane and an exclusive left-turn lane. As previously mentioned, even if a traffic signal is warranted, installation of a traffic signal system is not recommended at this intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Northbound traffic on Weliweli Road can use Ohuohu Street and Waikomo Road as an alternate route to Koloa Town.

Poipu Road/Kiahuna Tennis Club Driveway

The Kiahuna Tennis Club Driveway southbound shared left-turn and right-turn traffic will change from LOS D to LOS E during the PM peak hour of traffic. Year 2015 traffic volumes with the Project are not likely to meet MUTCD traffic signal warrants at the Poipu Road/Kiahuna Tennis Club Driveway intersection. It is not uncommon, however, for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway. Project-generated traffic is expected to increase the number of vehicles on the Kiahuna Tennis Club Driveway southbound approach by seven (7) vehicles during the PM peak hour of traffic.

Poipu Road/Kiahuna Plantation Drive

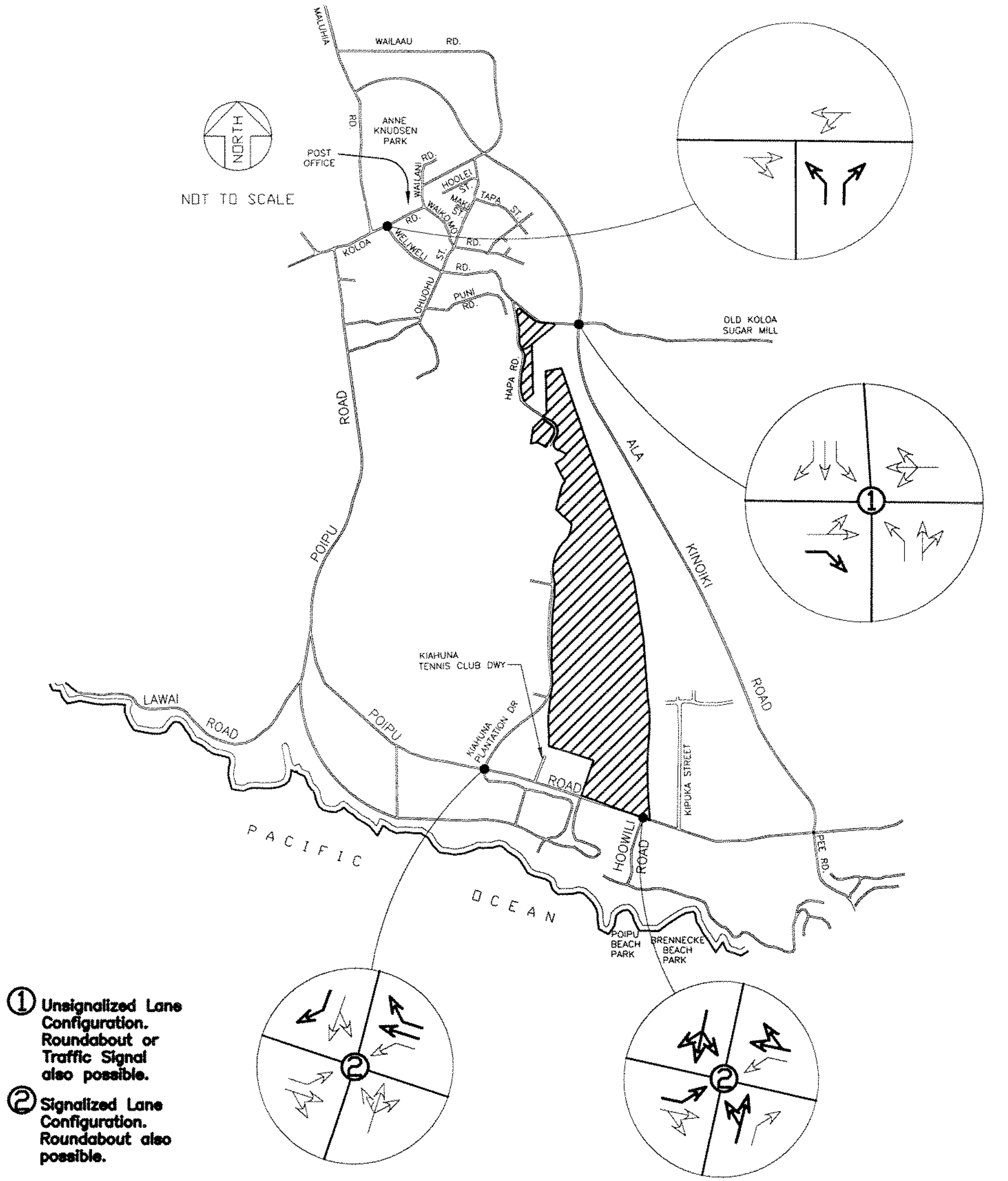
The southbound Kiahuna Plantation Drive approach, which is currently served by a shared right-turn/through/left-turn lane, will require an exclusive right-turn lane and a shared through/left-turn lane if a traffic signal is installed at this intersection. With the installation of a traffic signal and laneage modification as previously described, along with provision of an exclusive right-turn lane on the Poipu Road westbound approach as discussed for Base Year 2015, the Poipu Road/Kiahuna Plantation Drive intersection will operate overall at LOS B during the AM peak hour of traffic and LOS C during the PM peak hour of traffic. All individual movements will operate at LOS C or better during the AM peak hour of traffic and LOS D or better during the PM peak hour of traffic. Should a single-lane roundabout be constructed as previously discussed for Base Year 2010, traffic at this intersection will operate overall at LOS A during the AM peak hour of traffic and LOS B during the PM peak hour of traffic. Figure 15 shows the lane configurations for Year 2015 with the Project. Lane configurations are shown only for those intersections where laneage modifications are being proposed.

VI. CONCLUSIONS

A. Existing Conditions

Koloa Road

- Koloa Road is already approaching capacity with some individual movements at the Koloa Road/Maluhia Road intersection experiencing LOS E conditions and some individual movements at the Koloa Road/Poipu Road intersection experiencing LOS F and overcapacity conditions.
- The existing traffic volumes at the Koloa Road/Poipu Road intersection are likely to meet the MUTCD traffic signal warrants. However, installation of a traffic signal is not recommended at the Koloa Road/Poipu Road intersection due to its close proximity to the Koloa Road/Maluhia Road intersection. Should traffic signal systems be constructed on Koloa Road, queuing of traffic on Koloa Road is anticipated and will adversely impact traffic operations within Koloa Town.



ERIC KNUDSEN TRUST
VILLAGE AT POIPU
2005 UPDATE

ATA AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS, SURVEYORS • HONOLULU, HAWAII

YEAR 2015 RECOMMENDED LANE CONFIGURATION

FIGURE 15

- Construction of the pending Western Bypass from Lawai Road to Koloa Road should help alleviate the traffic demand at the Koloa Road/Poipu Road intersection.

B. Without Project-Generated Traffic

1. Base Year 2006

Koloa Road/Maluhia Road

- Koloa Road will exceed its capacity with some individual movements at the Koloa Road/Maluhia Road experiencing LOS F conditions by Base Year 2006 in addition to traffic at the Koloa Road/Poipu Road intersection continuing to experience LOS F and overcapacity conditions.
- If installation of a traffic signal is warranted in 2006, it is not recommended due to the close proximity to the Koloa Road/Poipu Road intersection.
- Southbound traffic on Maluhia Road can use Ala Kinoiki Road as an alternate route around Koloa Town.

Poipu Road/Ala Kinoiki Road/Pee Road

- Traffic will experience LOS F conditions during Base Year 2006.
- Base Year 2006 traffic volumes are not likely to warrant a traffic signal system; however, an AWSC configuration may be warranted per the criteria in MUTCD.
- As an AWSC intersection, traffic will operate overall at LOS B during the AM and PM peak hours of traffic.
- The construction of a single-lane roundabout, in lieu of the AWSC intersection, would improve operating conditions at this intersection to overall LOS A during the AM and PM peak hours of traffic.

2. Base Year 2010

There will be a lack of north-south capacity caused by the regional traffic demand in the Poipu/Kukui'ula areas if the traffic volumes projected for Base Year 2010 are realized. Some individual movements at the Koloa Road/Maluhia Road and Koloa Road/Poipu Road intersections will experience LOS F and overcapacity conditions.

Koloa Road/Weliweli Road

- Vehicles on the northbound Weliweli Road approach to Koloa Road, which are currently served by a shared right-turn/left-turn lane, will experience LOS F and overcapacity conditions by Base Year 2010.
- Northbound left-turn traffic will continue to operate at LOS F at overcapacity conditions if the Weliweli Road northbound approach to Koloa Road is modified to provide an exclusive right-turn lane and an exclusive left-turn lane.
- As previously mentioned, installation of traffic signals on Koloa Road is not recommended even if traffic signal warrants are met.

Maluhia Road/Ala Kinoiki Road

- Left-turn traffic on the westbound Ala Kinoiki Road approach to Maluhia Road will experience LOS E conditions.
- Base Year 2010 traffic volumes are not likely to warrant a traffic signal system at this intersection.
- It is not uncommon, however, for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway. Approximately 5 and 20 westbound vehicles on Ala Kinoiki Road are projected to turn left onto Maluhia Road during the AM and PM peak hours of traffic, respectively.

Ala Kinoiki Road/Weliweli Road

- Traffic will experience LOS E conditions during Base Year 2010.

- Base Year 2010 traffic volumes may warrant a traffic signal system at this intersection should the Weliweli Road eastbound traffic continue to be served by a shared right-turn/through/left-turn lane.
- With the installation of a traffic signal, traffic will operate overall at LOS B during the AM and PM peak hours of traffic.
- The construction of a single-lane roundabout, in lieu of a traffic signal, would improve operating conditions at this intersection to overall LOS A during the AM and PM peak hours of traffic.

Poipu Road/Hoowili Road

- Traffic will experience LOS F conditions during Base Year 2010.
- Base Year 2010 traffic volumes may warrant a traffic signal system at this intersection.
- With the installation of a traffic signal, traffic will operate overall at LOS A during the AM and PM peak hours of traffic.
- The construction of a single-lane roundabout, in lieu of a traffic signal, would improve operating conditions at this intersection to overall LOS A during the AM and PM peak hours of traffic.

Poipu Road/Kiahuna Plantation Drive

- Traffic at the Poipu Road/Kiahuna Plantation Drive intersection will experience LOS F and overcapacity conditions during Base Year 2010.
- Base Year 2010 traffic volumes are likely to warrant a traffic signal system at this intersection.
- With the installation of a traffic signal, traffic will operate overall at LOS A during the AM peak hour of traffic and LOS C during the PM peak hour of traffic.
- The construction of a single-lane roundabout, in lieu of a traffic signal, would improve operating conditions at this intersection to overall LOS A during the AM and PM peak hours of traffic.

3. Base Year 2015

Koloa Road

- Some individual movements at the Koloa Road/Maluhia Road, Koloa Road/Poipu Road and Koloa Road/Weliweli Road intersections will experience LOS F and overcapacity conditions.
- As previously mentioned, installation of traffic signals on Koloa Road is not recommended even if traffic signal warrants are met.

Maluhia Road/Ala Kinoiki Road

- Left-turn traffic on the westbound Ala Kinoiki Road approach to Maluhia Road will experience LOS F conditions.
- It is not uncommon, however, for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway. Approximately 5 and 25 westbound vehicles on Ala Kinoiki Road are projected to turn left onto Maluhia Road during the AM and PM peak hours of traffic, respectively.

Poipu Road/Ala Kinoiki Road/Pee Road

- As an AWSC intersection, traffic will experience LOS E conditions during Base Year 2015.
- The construction of a single-lane roundabout, in lieu of the AWSC intersection, as previously discussed for Base Year 2006 would improve operating conditions at this intersection to overall LOS A during the AM and PM peak hours of traffic.

Poipu Road/Kiahuna Plantation Drive

- Should a traffic signal be installed, traffic on the westbound Poipu Road approach to Kiahuna Plantation Drive, which is currently served by a shared right-turn/through lane and an exclusive left-turn lane, will require an exclusive right-turn lane, a through lane and an exclusive left-turn lane for Base Year 2015.

- With the installation of a traffic signal and laneage modification as previously described, traffic will operate overall at LOS B during the AM peak hour of traffic and LOS D during the PM peak hour of traffic.
- The construction of a single-lane roundabout, in lieu of a traffic signal, would improve operating conditions at this intersection to overall LOS A during the AM and PM peak hours of traffic.

C. With Project-Generated Traffic

1. Year 2006 With the Project

- Phase 1 of the Project is expected to generate approximately 33 trips during the AM peak hour of traffic and 40 trips during the PM peak hour of traffic.
- Year 2006 Project-generated traffic will utilize Kiahuna Plantation Drive and the Kiahuna Tennis Club Driveway.
- Traffic at the study intersections will operate similar to Base Year 2006 with no major traffic impacts resulting from the Project.

2. Year 2010 With the Project

- Phases 1 and 2 of the Project are expected to generate approximately 130 trips during the AM peak hour of traffic and 165 trips during the PM peak hour of traffic.
- Year 2010 Project-generated traffic will utilize Kiahuna Plantation Drive, the Kiahuna Tennis Club Driveway, Driveway A and Kipuka Street.
- The Poipu Road/Hoowili Road/Driveway A intersection will require the following laneage should a traffic signal be installed at this intersection:
  - an exclusive right-turn lane and a shared through/left-turn lane on the northbound Hoowili Road approach,
  - a shared right-turn/through/left-turn lane on the southbound Driveway A approach,

- a shared right-turn/through lane and an exclusive left-turn lane on the westbound and eastbound Poipu Road approaches.

- With the installation of a traffic signal and laneage as previously described, the Poipu Road/Hoowili Road/Driveway A intersection will operate overall at LOS A during the AM peak hour of traffic and LOS B during the PM peak hour of traffic.

- The construction of a single-lane roundabout at the Poipu Road/Hoowili Road/Driveway A intersection, in lieu of a traffic signal, would improve operating conditions at this intersection to overall LOS A during the AM and PM peak hours of traffic.

- Traffic at the other study intersections will operate similar to Base Year 2010 with no major traffic impacts resulting from the Project.

3. Year 2015 With the Project

- Buildout of the Project is expected to generate approximately 242 trips during the AM peak hour of traffic and 320 trips during the PM peak hour of traffic.

- Year 2015 Project-generated traffic will utilize five access points (Kiahuna Plantation Drive, the Kiahuna Tennis Club Driveway, Driveway A, Kipuka Street and Hapa Road).

- Traffic at the study intersections will operate similar to Base Year 2015 except for the following.

- Traffic on the southbound Kiahuna Tennis Club Driveway approach to Poipu Road will experience LOS E conditions during Year 2015 with the Project. Year 2015 traffic volumes with the Project are not likely to meet MUTCD traffic signal warrants at the Poipu Road/Kiahuna Tennis Club Driveway intersection; however, it is not uncommon for a side street to experience long delays especially when trying to execute a left-turn onto a major roadway.

- Should a traffic signal be installed at the Poipu Road/Kiahuna Plantation Drive intersection, traffic on the southbound Kiahuna Plantation Drive approach to Poipu Road, which is currently served by a shared right-turn/through/left-turn lane, will require an exclusive right-turn lane and a shared through/left-turn lane for Year 2015 with the Project.

- With the installation of a traffic signal and laneage modification as previously described, along with provision of an exclusive right-turn lane on the Poipu Road westbound approach as discussed for Base Year 2015, the Poipu Road/Kiahuna Plantation Drive intersection will operate overall at LOS B during the AM peak hour of traffic and LOS C during the PM peak hour of traffic.
- The construction of a single-lane roundabout at the Poipu Road/Kiahuna Plantation Drive intersection, in lieu of a traffic signal, would improve operating conditions at this intersection to overall LOS A during the AM peak hour of traffic and LOS B during the PM peak hour of traffic.

VII. RECOMMENDATIONS

A. Without Project-Generated Traffic

The following are the recommendations of the traffic study that would be needed even <u>without</u> Project-generated traffic.

<u>Western Bypass</u>

Pursue development of the north leg of the Western Bypass from Koloa Road to Maluhia Road or other north-south roadways by Year 2010.

<u>Poipu Road/Ala Kinoiki Road/Pee Road</u>

- Reconfigure the Poipu Road/Ala Kinoiki Road/Pee Road intersection as an AWSC intersection, or construct a single-lane roundabout by Year 2006.
- Construct a single-lane roundabout by Year 2015.

Koloa Road/Weliweli Road

Modify the Weliweli Road northbound approach to Koloa Road to provide an exclusive right-turn lane and an exclusive left-turn lane by Year 2010.

Ala Kinoiki Road/Weliweli Road

- Monitor traffic volumes at this intersection and install a traffic signal when warranted.
- If a traffic signal is not installed, install a single-lane roundabout or modify the Weliweli Road eastbound approach to provide an exclusive right-turn lane and shared through/left-turn lane by Year 2010.

Poipu Road/Hoowili Road

- Monitor traffic volumes at this intersection and install a traffic signal when warranted or install a single-lane roundabout by Year 2010.

Poipu Road/Kiahuna Plantation Drive

- Monitor traffic volumes at this intersection and install a traffic signal when warranted or install a single-lane roundabout by Year 2010.
- If a traffic signal is installed, modify the westbound Poipu Road approach to provide an exclusive right-turn lane, a through lane and an exclusive left-turn lane by Year 2015.

B. With Project-Generated Traffic

The following are the recommendations of the traffic study that would be needed with Project-generated traffic.

Poipu Road/Hoowili Road/Driveway A

If a traffic signal is installed, provide the following laneage by Year 2010:

- an exclusive right-turn lane and a shared through/left-turn lane on the northbound Hoowili Road approach,
- a shared right-turn/through/left-turn lane on the southbound Driveway A approach,

- a shared right-turn/through lane and an exclusive left-turn lane on the westbound and eastbound Poipu Road approaches.

Poipu Road/Kiahuna Plantation Drive

- If a traffic signal is installed, modify the southbound Kiahuna Plantation Drive approach to provide an exclusive right-turn lane and a shared through/left-turn lane by Year 2015. This is in addition to modifying the westbound Poipu Road approach to provide an exclusive right-turn lane, a through lane and an exclusive left-turn lane as recommended for Base Year 2015.

REFERENCES

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11. U.S. Department of Transportation, Federal Highway Administration, MUTCD 2000 – Manual on Uniform Traffic Control Devices – Millennium Edition, December 2000, amended June 2001.

APPENDICES

APPENDIX A

EXISTING TRAFFIC COUNT DATA

Austin, Tsutsumi & Associates, Inc.
501 Sumner Street, Suite 521
Honolulu, Hawaii 96817
Ph: (808) 533-3646 Fax: (808) 526-1267

Major Street: Koloa Road
Minor Street: Weliweli Road
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : KOLWELAM
Site Code : 00000000
Start Date : 06/05/2003
Page No : 1

Groups Printed- vehicles

	WELIWELI ROAD Southbound					KOLOA ROAD Westbound					WELIWELI ROAD Northbound					KOLOA ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
06:30 AM	0	0	0	0	0	0	24	0	0	24	1	0	13	4	18	37	13	0	0	50	92
06:45 AM	0	0	0	0	0	0	23	0	0	23	0	0	14	0	14	29	24	0	0	53	90
Total	0	0	0	0	0	0	47	0	0	47	1	0	27	4	32	66	37	1	0	104	183
07:00 AM	0	0	0	0	0	0	34	4	0	38	0	0	19	2	21	29	40	0	0	69	128
07:15 AM	0	0	0	0	0	2	51	2	0	55	3	0	12	1	16	29	32	0	0	61	132
07:30 AM	0	0	0	0	0	0	46	3	0	49	1	0	12	0	13	46	55	0	0	101	163
07:45 AM	0	0	0	0	0	0	41	1	0	42	0	0	5	4	9	43	79	0	0	122	173
Total	0	0	0	0	0	2	172	10	0	184	4	0	48	7	59	147	206	0	0	353	596
08:00 AM	0	0	0	0	0	0	37	4	0	41	2	0	10	0	12	23	57	0	0	80	133
08:15 AM	0	0	0	0	0	0	31	3	0	34	2	0	10	1	13	21	56	0	0	77	124
Grand Total	0	0	0	0	0	2	287	17	0	306	9	0	95	12	116	257	356	1	0	614	1036
Apprch %	0.0	0.0	0.0	0.0		0.7	93.8	5.6	0.0		7.8	0.0	81.9	10.3		41.9	58.0	0.2	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.2	27.7	1.6	0.0	29.5	0.9	0.0	9.2	1.2	11.2	24.8	34.4	0.1	0.0	59.3	

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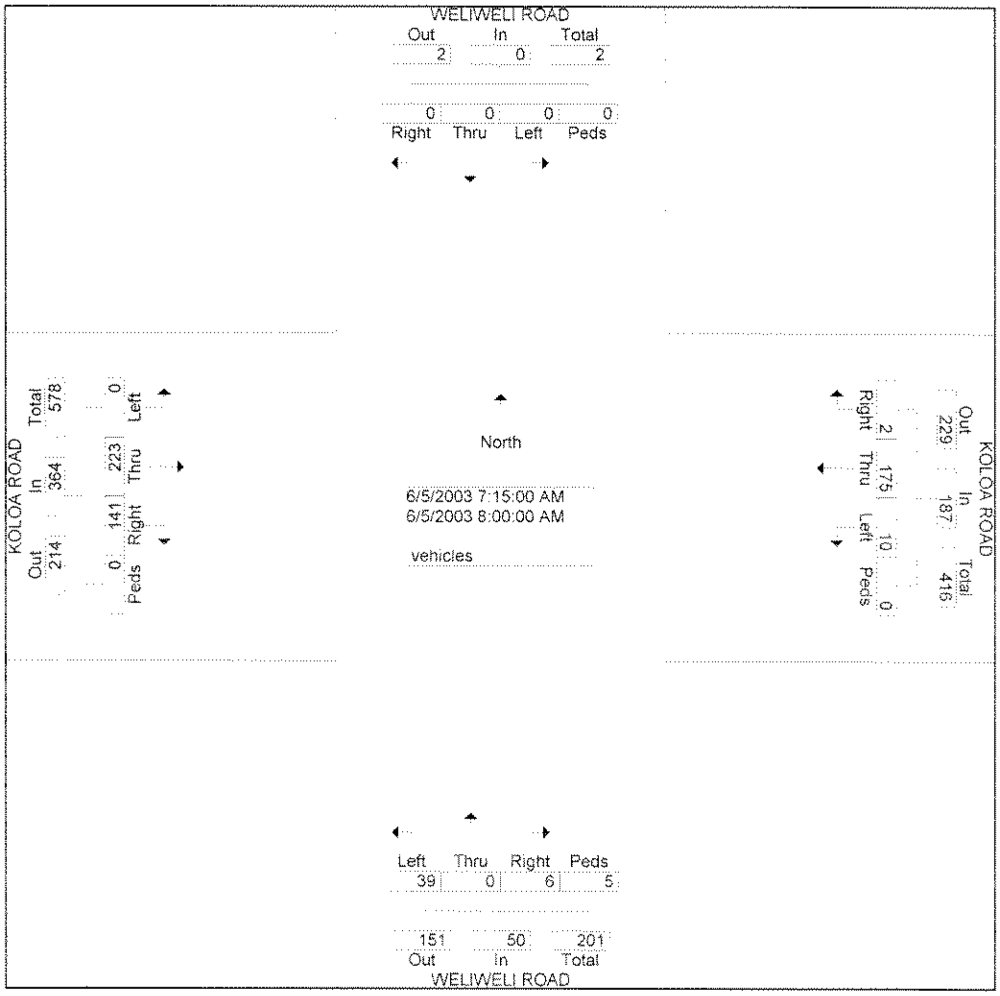
Ph: (808) 533-3646 Fax: (808) 526-1267

Major Street: Koloa Road
Minor Street: Weliweli Road
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : KOLWELAM
Site Code : 00000000
Start Date : 06/05/2003

	WELIWELI ROAD Southbound					KOLOA ROAD Westbound					WELIWELI ROAD Northbound					KOLOA ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 06:15 AM to 08:15 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	0	0	0	0	0	2	175	10	0	187	6	0	39	5	50	141	223	0	0	364	601
Percent	0.0	0.0	0.0	0.0		1.1	93.6	5.3	0.0		12.0	0.0	78.0	10.0		38.7	61.3	0.0	0.0		
07:45 Volume	0	0	0	0	0	0	41	1	0	42	0	0	5	4	9	43	79	0	0	122	173
Peak Factor																					0.868
High Int.	6:00:00 AM					07:15 AM					07:15 AM					07:45 AM					
Volume	0	0	0	0	0	2	51	2	0	55	3	0	12	1	16	43	79	0	0	122	
Peak Factor										0.850					0.781					0.746	



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Major Street: Koloa Road
Minor street: Weliweli Road
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : KOLWELPM
Site Code : 00000000
Start Date : 06/04/2003
Page No : 1

Groups Printed- vehicles

	WELIWELI ROAD Southbound					KOLOA ROAD Westbound					WELIWELI ROAD Northbound					KOLOA ROAD Eastbound					
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03:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
03:30 PM	0	0	0	0	0	0	78	5	0	83	5	0	19	0	24	28	67	0	0	95	202
03:45 PM	0	0	0	0	0	0	67	10	0	77	7	0	25	3	35	31	75	0	4	110	222
Total	0	0	0	0	0	0	145	15	0	160	12	0	44	3	59	59	142	1	4	206	425
04:00 PM	0	0	0	0	0	0	75	4	0	79	8	0	33	2	43	19	65	0	2	86	208
04:15 PM	0	0	0	0	0	0	73	1	0	74	3	0	23	1	27	21	68	2	0	91	192
04:30 PM	0	0	0	0	0	0	78	4	0	82	6	0	19	1	26	31	77	0	0	108	216
04:45 PM	0	0	0	0	0	0	55	3	0	58	5	0	18	1	24	25	57	0	0	82	164
Total	0	0	0	0	0	0	281	12	0	293	22	0	93	5	120	96	267	2	2	367	780
05:00 PM	0	0	0	0	0	0	56	1	0	57	7	0	22	15	44	24	63	0	0	87	188
05:15 PM	0	0	0	0	0	0	52	3	0	55	3	0	22	4	29	29	54	0	0	83	167
Grand Total	0	0	0	0	0	0	534	31	0	565	44	0	181	27	252	208	526	3	6	743	1560
Apprch %	0.0	0.0	0.0	0.0		0.0	94.5	5.5	0.0		17.5	0.0	71.8	10.7		28.0	70.8	0.4	0.8		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	34.2	2.0	0.0	36.2	2.8	0.0	11.6	1.7	16.2	13.3	33.7	0.2	0.4	47.6	

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Major Street: Koloa Road
Minor street: Weliweli Road
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : KOLWELPM
Site Code : 00000000
Start Date : 06/04/2003

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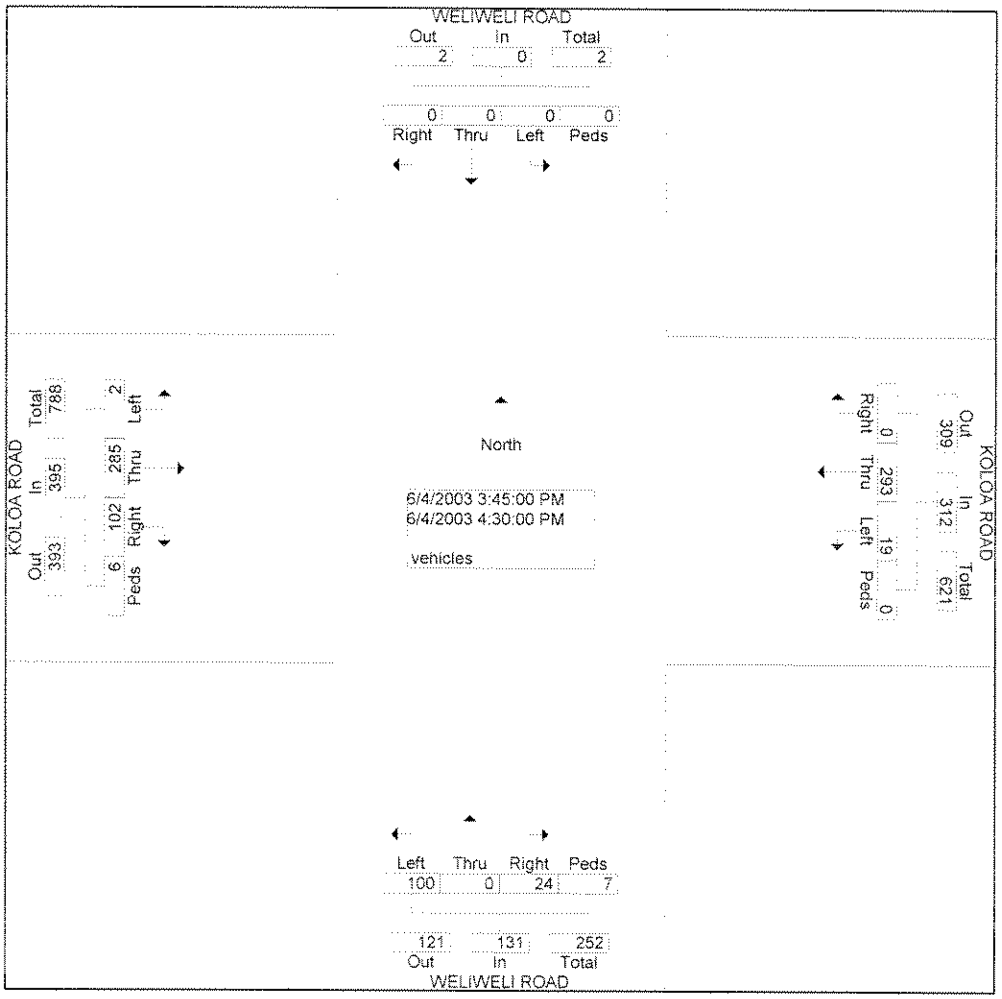
Peak Hour From 03:15 PM to 05:15 PM - Peak 1 of 1																					
Intersection	03:45 PM																				
Volume	0	0	0	0	0	0	293	19	0	312	24	0	100	7	131	102	285	2	6	395	838
Percent	0.0	0.0	0.0	0.0		0.0	93.9	6.1	0.0		18.3	0.0	76.3	5.3		25.8	72.2	0.5	1.5		
03:45 Volume	0	0	0	0	0	0	67	10	0	77	7	0	25	3	35	31	75	0	4	110	222
Peak Factor																					0.944
High Int.	3:00:00 PM					04:30 PM					04:00 PM					03:45 PM					
Volume	0	0	0	0	0	0	78	4	0	82	8	0	33	2	43	31	75	0	4	110	
Peak Factor										0.951					0.762					0.898	



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Major Street: Weliweli Road
Minor Street: Hapa Road
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : WELHAPAM
Site Code : 00000000
Start Date : 06/05/2003
Page No : 1

Groups Printed- vehicles

	WELIWELI ROAD Southbound					HAPA ROAD Westbound					WELIWELI ROAD Northbound					HAPA ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 AM	1	39	0	0	40	0	0	0	0	0	0	16	0	0	16	0	0	0	0	0	56
06:45 AM	5	29	0	0	34	0	0	0	0	0	0	13	2	0	15	0	0	1	0	1	50
Total	6	68	0	0	74	0	0	0	0	0	0	29	2	0	31	0	0	1	0	1	106
07:00 AM	0	24	0	0	24	0	0	0	0	0	0	12	0	0	12	0	0	2	0	2	38
07:15 AM	0	40	0	0	40	0	0	0	0	0	0	16	0	0	16	0	0	3	0	3	59
07:30 AM	1	47	0	0	48	0	0	0	0	0	0	11	0	0	11	3	0	4	0	7	66
07:45 AM	0	59	0	0	59	0	0	0	0	0	0	9	0	0	9	2	0	1	0	3	71
Total	1	170	0	0	171	0	0	0	0	0	0	48	0	0	48	5	0	10	0	15	234
08:00 AM	2	26	0	0	28	0	0	0	0	0	0	17	0	0	17	1	0	0	0	1	46
08:15 AM	1	31	0	0	32	0	0	0	0	0	0	11	0	0	11	1	0	0	0	1	44
Grand Total	10	295	0	0	305	0	0	0	0	0	0	105	2	0	107	7	0	11	0	18	430
Apprch %	3.3	96.7	0.0	0.0		0.0	0.0	0.0	0.0		0.0	98.1	1.9	0.0		38.9	0.0	61.1	0.0		
Total %	2.3	68.6	0.0	0.0	70.9	0.0	0.0	0.0	0.0	0.0	0.0	24.4	0.5	0.0	24.9	1.6	0.0	2.6	0.0	4.2	

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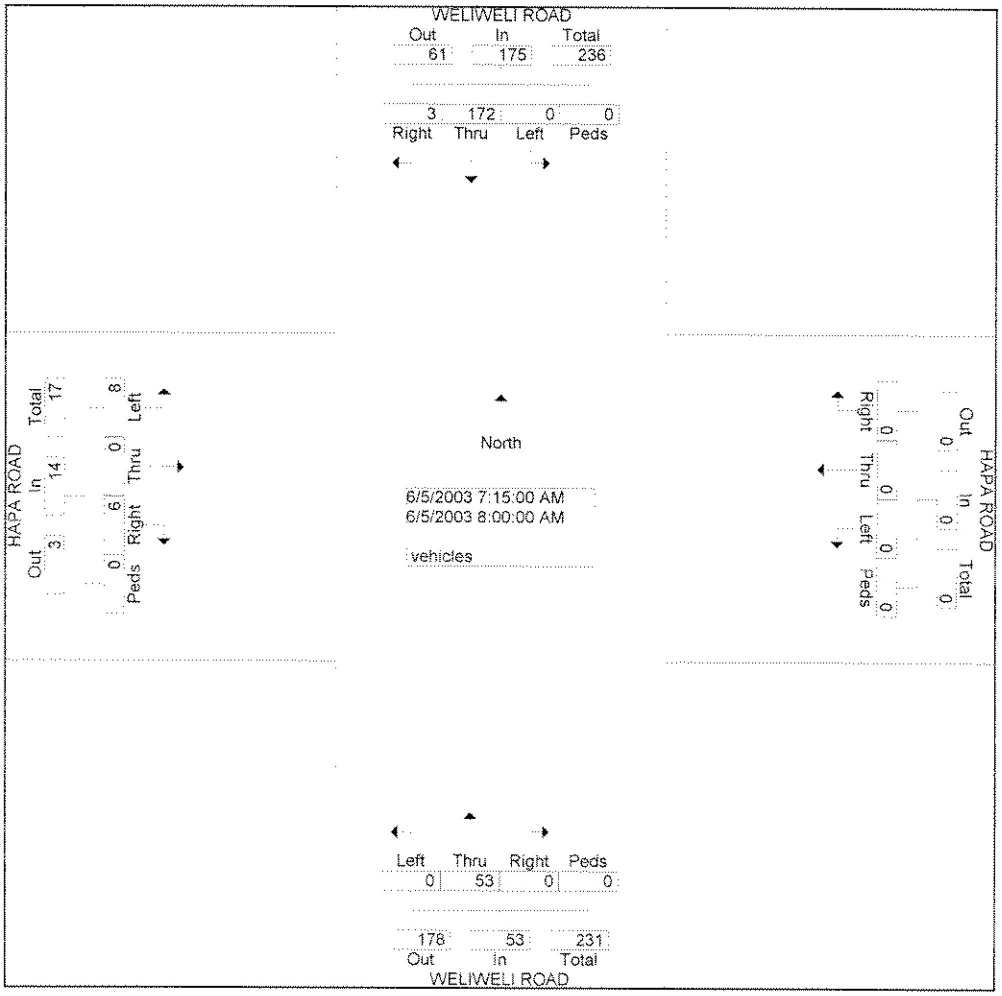
Major Street: Weliweli Road
Minor Street: Hapa Road
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : WELHAPAM
Site Code : 00000000
Start Date : 06/05/2003

	WELIWELI ROAD Southbound					HAPA ROAD Westbound					WELIWELI ROAD Northbound					HAPA ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 06:15 AM to 08:15 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	3	172	0	0	175	0	0	0	0	0	0	53	0	0	53	6	0	8	0	14	242
Percent	1.7	98.3	0.0	0.0		0.0	0.0	0.0	0.0		0.0	100.0	0.0	0.0		42.9	0.0	57.1	0.0		
07:45 Volume	0	59	0	0	59	0	0	0	0	0	0	9	0	0	9	2	0	1	0	3	71
Peak Factor																					0.852
High Int.	07:45 AM					6:00:00 AM					08:00 AM					07:30 AM					
Volume	0	59	0	0	59	0	0	0	0	0	0	17	0	0	17	3	0	4	0	7	
Peak Factor					0.742										0.779					0.500	



Major Street: Weliweli Road
Minor Street: Hapa Road
Time of Count: 3:30 PM-5:30 PM
Weather:

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File Name : WELHAPPM
Site Code : 00000000
Start Date : 06/04/2003

Groups Printed- vehicles

	WELIWELI ROAD Southbound					HAPA ROAD Westbound					WELIWELI ROAD Northbound					HAPA ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:30 PM	1	18	0	0	19	0	0	0	0	0	0	37	0	0	37	0	0	0	0	0	56
03:45 PM	1	26	0	0	27	0	0	0	0	0	0	31	0	0	31	0	0	3	0	3	61
Total	2	44	0	0	46	0	0	0	0	0	0	68	0	0	68	0	0	3	0	3	117
04:00 PM	1	25	0	0	26	0	0	0	0	0	0	40	1	0	41	0	0	0	0	0	67
04:15 PM	4	15	0	0	19	0	0	0	0	0	0	33	0	0	33	1	0	1	0	2	54
04:30 PM	4	25	0	0	29	0	0	0	0	0	0	38	0	0	38	0	0	1	0	1	68
04:45 PM	0	24	0	0	24	0	0	0	0	0	0	21	0	0	21	0	0	2	0	2	47
Total	9	89	0	0	98	0	0	0	0	0	0	132	1	0	133	1	0	4	0	5	236
05:00 PM	2	18	0	0	20	0	0	0	0	0	0	35	0	0	35	1	0	2	0	3	58
05:15 PM	0	25	0	0	25	0	0	0	0	0	0	23	1	0	24	0	0	1	0	1	50
Grand Total	13	176	0	0	189	0	0	0	0	0	0	258	2	0	260	2	0	10	0	12	461
Apprch %	6.9	93.1	0.0	0.0		0.0	0.0	0.0	0.0		0.0	99.2	0.8	0.0		16.7	0.0	83.3	0.0		
Total %	2.8	38.2	0.0	0.0	41.0	0.0	0.0	0.0	0.0	0.0	0.0	56.0	0.4	0.0	56.4	0.4	0.0	2.2	0.0	2.6	

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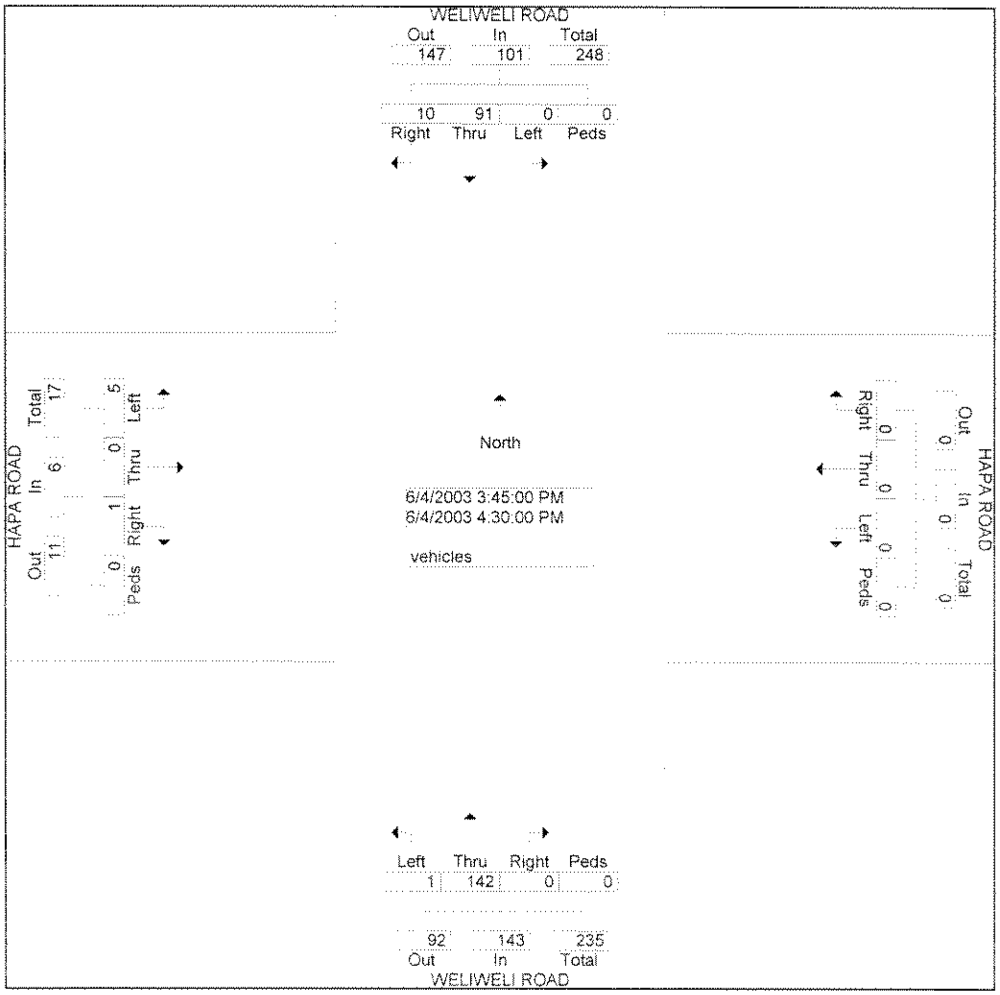
Major Street: Weliweli Road
Minor Street: Hapa Road
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : WELHAPPM
Site Code : 00000000
Start Date : 06/04/2003

	WELIWELI ROAD Southbound					HAPA ROAD Westbound					WELIWELI ROAD Northbound					HAPA ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 03:30 PM to 05:15 PM - Peak 1 of 1																					
Intersection	03:45 PM																				
Volume	10	91	0	0	101	0	0	0	0	0	0	142	1	0	143	1	0	5	0	6	250
Percent	9.9	90.1	0.0	0.0		0.0	0.0	0.0	0.0		0.0	99.3	0.7	0.0		16.7	0.0	83.3	0.0		
04:30 Volume	4	25	0	0	29	0	0	0	0	0	0	38	0	0	38	0	0	1	0	1	68
Peak Factor																					0.919
High Int.	04:30 PM					3:15:00 PM					04:00 PM					03:45 PM					
Volume	4	25	0	0	29	0	0	0	0	0	0	40	1	0	41	0	0	3	0	3	
Peak Factor					0.871										0.872					0.500	



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Major Street: Ala Kinoiki Road
Minor Street: Weliweli Road
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : ALAWELAM
Site Code : 00000000
Start Date : 06/05/2003

Groups Printed- vehicles

	WELIWELI ROAD Southbound					ALA KINOIKI ROAD Westbound					WELIWELI ROAD Northbound					ALA KINOIKI ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
06:30 AM	33	7	0	0	40	0	25	1	0	26	1	0	0	0	1	0	30	15	0	45	112
06:45 AM	26	4	0	0	30	1	22	0	0	23	2	0	1	0	3	0	11	14	0	25	81
Total	59	11	0	0	70	1	47	1	0	49	3	0	1	0	4	0	41	30	0	71	194
07:00 AM	21	3	0	0	24	0	27	1	0	28	1	2	0	0	3	2	23	9	0	34	89
07:15 AM	37	2	0	0	39	0	33	2	0	35	1	0	0	0	1	1	23	17	0	41	116
07:30 AM	43	6	1	0	50	0	38	1	0	39	0	3	0	0	3	0	27	7	0	34	126
07:45 AM	50	10	0	0	60	0	33	0	0	33	2	1	0	0	3	0	34	10	0	44	140
Total	151	21	1	0	173	0	131	4	0	135	4	6	0	0	10	3	107	43	0	153	471
08:00 AM	25	2	1	0	28	2	32	1	0	35	2	1	0	0	3	0	29	11	0	40	106
08:15 AM	31	1	0	0	32	0	29	1	0	30	2	3	1	0	6	0	27	10	0	37	105
Grand Total	266	35	2	0	303	3	239	7	0	249	11	10	2	0	23	3	204	94	0	301	876
Apprch %	87.8	11.6	0.7	0.0		1.2	96.0	2.8	0.0		47.8	43.5	8.7	0.0		1.0	67.8	31.2	0.0		
Total %	30.4	4.0	0.2	0.0	34.6	0.3	27.3	0.8	0.0	28.4	1.3	1.1	0.2	0.0	2.6	0.3	23.3	10.7	0.0	34.4	

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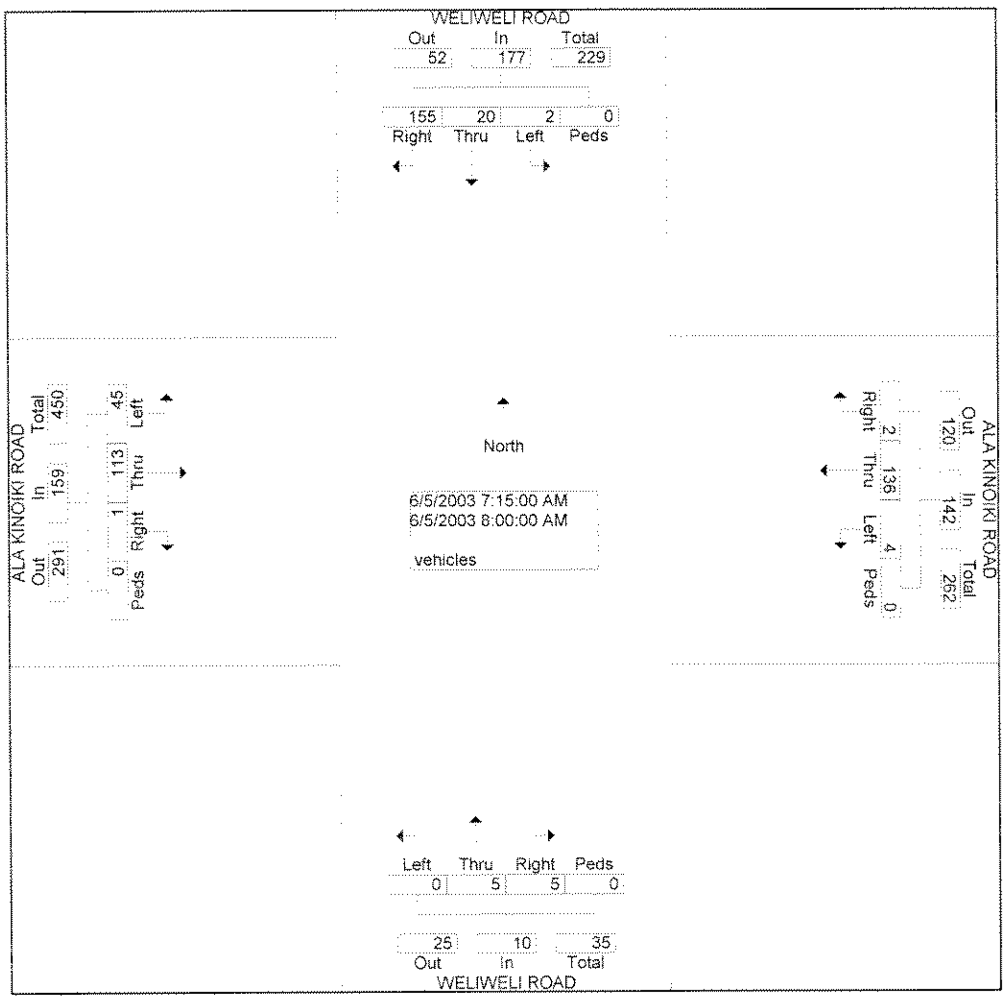
Major Street: Ala Kinoiki Road
Minor Street: Weliweli Road
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : ALAWELAM
Site Code : 00000000
Start Date : 06/05/2003

	WELIWELI ROAD Southbound					ALA KINOIKI ROAD Westbound					WELIWELI ROAD Northbound					ALA KINOIKI ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 06:15 AM to 08:15 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	155	20	2	0	177	2	136	4	0	142	5	5	0	0	10	1	113	45	0	159	488
Percent	87.6	11.3	1.1	0.0		1.4	95.8	2.8	0.0		50.0	50.0	0.0	0.0		0.6	71.1	28.3	0.0		
07:45 Volume	50	10	0	0	60	0	33	0	0	33	2	1	0	0	3	0	34	10	0	44	140
Peak Factor																					0.871
High Int.	07:45 AM					07:30 AM					07:30 AM					07:45 AM					
Volume	50	10	0	0	60	0	38	1	0	39	0	3	0	0	3	0	34	10	0	44	
Peak Factor					0.738					0.910					0.833					0.903	



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Major Street: Ala Kinoiki Road
Minor Street: Weliweli Road
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : ALAWELPM
Site Code : 00000000
Start Date : 06/04/2003
Page No : 1

Groups Printed- vehicles

	WELIWELI ROAD Southbound					ALA KINOIKI ROAD Westbound					WELIWELI ROAD Northbound					ALA KINOIKI ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:30 PM	17	0	2	0	19	1	32	0	0	33	0	4	0	0	4	1	41	31	0	73	129
03:45 PM	23	3	0	0	26	0	34	2	0	36	3	3	2	0	8	2	36	31	0	69	139
Total	40	3	2	0	45	1	66	2	0	69	3	7	2	0	12	3	77	62	0	142	268
04:00 PM	26	2	0	0	28	0	44	2	0	46	2	0	1	0	3	1	64	40	0	105	182
04:15 PM	13	3	1	0	17	1	41	2	0	44	3	6	1	0	10	2	45	23	0	70	141
04:30 PM	21	3	1	0	25	0	49	0	0	49	0	11	1	0	12	2	61	31	0	94	180
04:45 PM	21	3	1	0	25	0	40	2	0	42	2	1	2	0	5	0	44	20	0	64	136
Total	81	11	3	0	95	1	174	6	0	181	7	18	5	0	30	5	214	114	0	333	639
05:00 PM	16	3	0	0	19	0	43	3	0	46	1	5	1	0	7	0	47	36	0	83	155
05:15 PM	26	1	0	0	27	0	44	0	0	44	1	1	0	0	2	0	37	26	0	63	136
Grand Total	163	18	5	0	186	2	327	11	0	340	12	31	8	0	51	8	375	238	0	621	1198
Apprch %	87.6	9.7	2.7	0.0		0.6	96.2	3.2	0.0		23.5	60.8	15.7	0.0		1.3	60.4	38.3	0.0		
Total %	13.6	1.5	0.4	0.0	15.5	0.2	27.3	0.9	0.0	28.4	1.0	2.6	0.7	0.0	4.3	0.7	31.3	19.9	0.0	51.8	

Major Street: Ala Kinoiki Road
Minor Street: Weliweli Road
Time of Count: 3:30 PM-5:30 PM
Weather:

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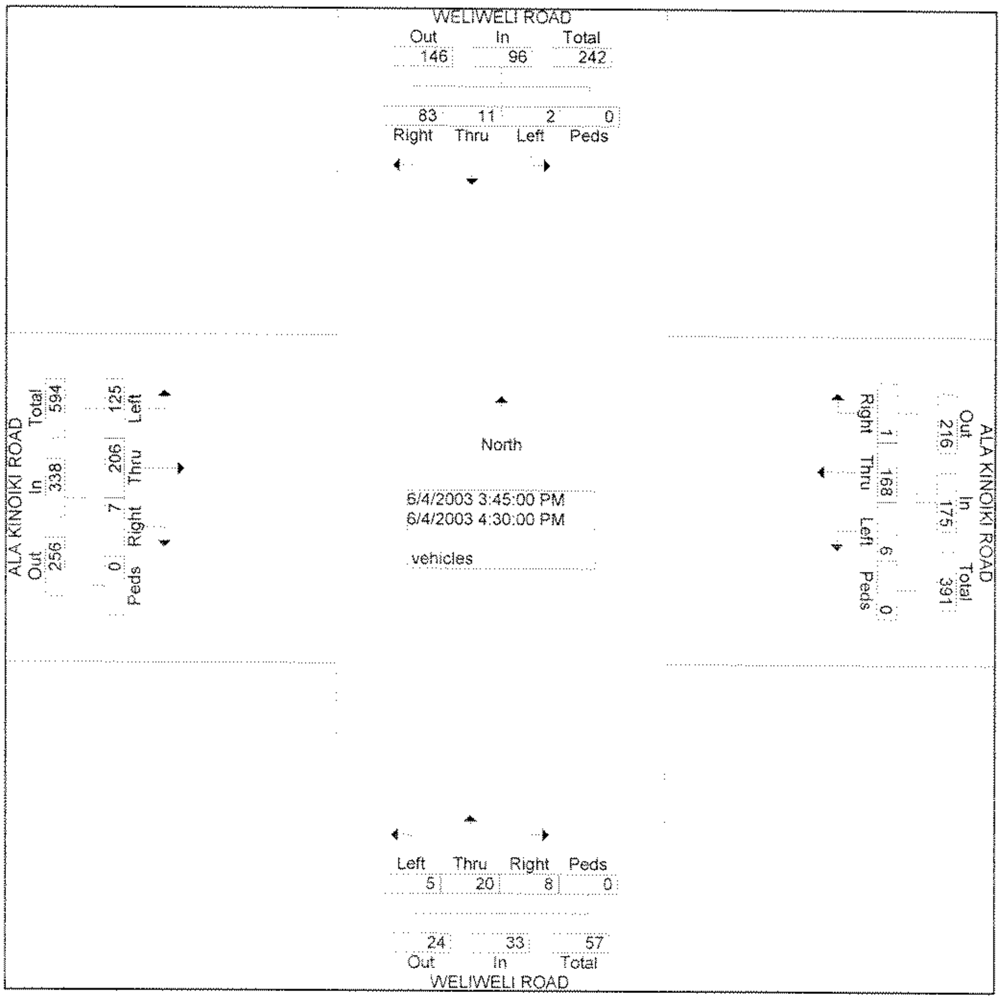
File Name : ALAWELPM
Site Code : 00000000
Start Date : 06/04/2003

	WELIWELI ROAD Southbound					ALA KINOIKI ROAD Westbound					WELIWELI ROAD Northbound					ALA KINOIKI ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 03:30 PM to 05:15 PM - Peak 1 of 1																					
Intersection	03:45 PM																				
Volume	83	11	2	0	96	1	168	6	0	175	8	20	5	0	33	7	206	125	0	338	642
Percent	86.5	11.5	2.1	0.0		0.6	96.0	3.4	0.0		24.2	60.6	15.2	0.0		2.1	60.9	37.0	0.0		
04:00 Volume	26	2	0	0	28	0	44	2	0	46	2	0	1	0	3	1	64	40	0	105	182
Peak Factor																					0.882
High Int.	04:00 PM					04:30 PM					04:30 PM					04:00 PM					
Volume	26	2	0	0	28	0	49	0	0	49	0	11	1	0	12	1	64	40	0	105	
Peak Factor					0.857					0.893					0.688					0.805	



Major Street: Poipu Road
Minor Street: Ala Kinoiki Road
Time of Count: 6:30 AM-8:30 AM
Weather:

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File Name : POIALAAM
Site Code : 00000000
Start Date : 06/04/2003
Page No : 1

Groups Printed- vehicles

	POIPU ROAD Southbound					ALA KINOIKI ROAD Westbound					POIPU ROAD Northbound					PEE ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 AM	2	6	13	0	21	5	9	27	0	41	5	0	0	0	5	0	13	4	0	17	84
06:45 AM	9	9	14	0	32	10	10	27	0	47	8	2	0	0	10	7	9	11	0	27	116
Total	11	15	27	0	53	15	19	54	0	88	13	2	0	0	15	7	22	15	0	44	200
07:00 AM	3	20	10	0	33	16	4	30	0	50	9	4	0	0	13	2	9	9	0	20	116
07:15 AM	7	13	14	0	34	24	16	41	0	81	5	2	2	0	9	1	10	12	0	23	147
07:30 AM	13	6	11	0	30	16	29	35	0	80	8	7	0	0	15	1	17	13	0	31	156
07:45 AM	11	13	10	0	34	21	31	31	0	83	10	7	2	0	19	2	10	6	0	18	154
Total	34	52	45	0	131	77	80	137	0	294	32	20	4	0	56	6	46	40	0	92	573
08:00 AM	11	12	16	0	39	19	22	26	0	67	5	9	2	0	16	4	17	8	0	29	151
08:15 AM	9	15	14	0	38	17	25	25	0	67	8	7	7	0	22	3	11	8	0	22	149
Grand Total	65	94	102	0	261	128	146	242	0	516	58	38	13	0	109	20	96	71	0	187	1073
Apprch %	24.9	36.0	39.1	0.0		24.8	28.3	46.9	0.0		53.2	34.9	11.9	0.0		10.7	51.3	38.0	0.0		
Total %	6.1	8.8	9.5	0.0	24.3	11.9	13.6	22.6	0.0	48.1	5.4	3.5	1.2	0.0	10.2	1.9	8.9	6.6	0.0	17.4	

Major Street: Poipu Road
Minor Street: Ala Kinoiki Road
Time of Count: 6:30 AM-8:30 AM
Weather:

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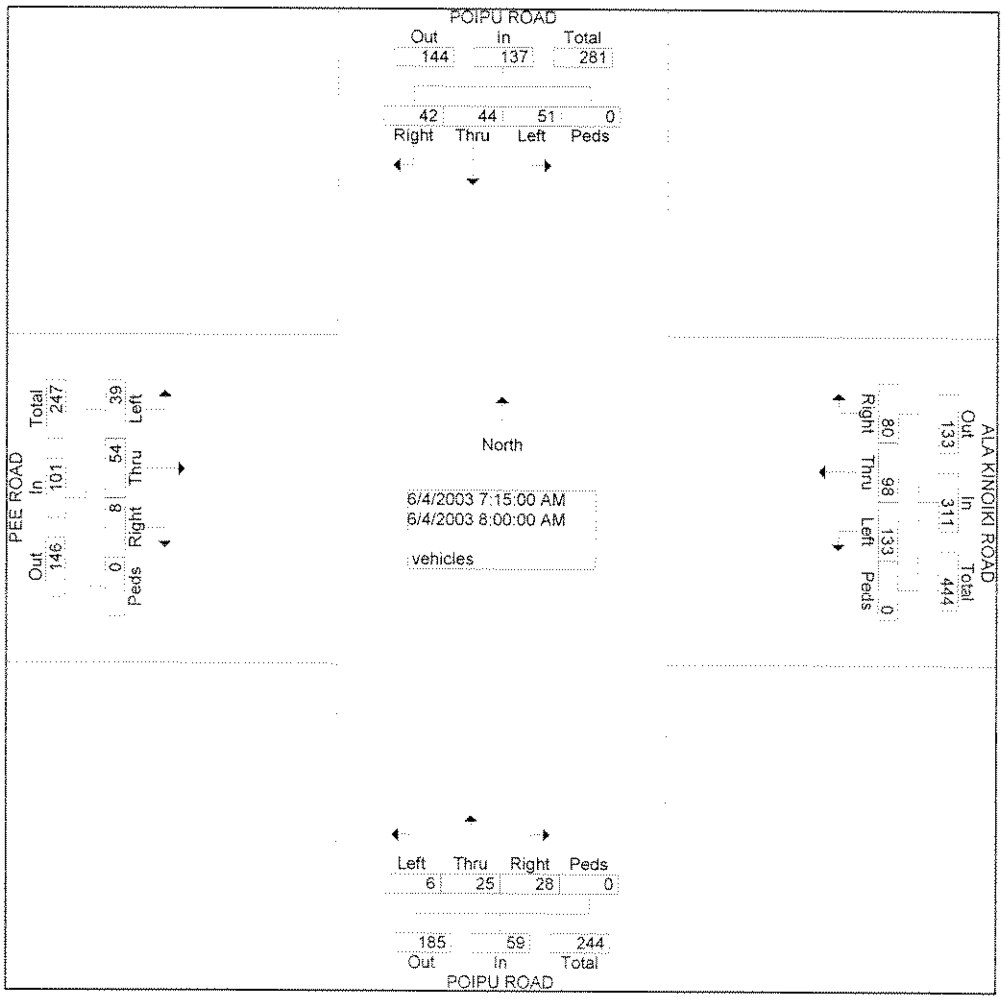
File Name : POIALAAM
Site Code : 00000000
Start Date : 06/04/2003

	POIPU ROAD Southbound					ALA KINOIKI ROAD Westbound					POIPU ROAD Northbound					PEE ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 07:15 AM to 08:00 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	42	44	51	0	137	80	98	133	0	311	28	25	6	0	59	8	54	39	0	101	608
Percent	30.7	32.1	37.2	0.0		25.7	31.5	42.8	0.0		47.5	42.4	10.2	0.0		7.9	53.5	38.6	0.0		
07:30 Volume	13	6	11	0	30	16	29	35	0	80	8	7	0	0	15	1	17	13	0	31	156
Peak Factor																					0.974
High Int.	08:00 AM					07:45 AM					07:45 AM					07:30 AM					
Volume	11	12	16	0	39	21	31	31	0	83	10	7	2	0	19	1	17	13	0	31	
Peak Factor					0.878					0.937					0.776					0.815	



Austin, Tsutsumi & Associates, Inc.
501 Sumner Street, Suite 521
Honolulu, Hawaii 96817
Ph: (808) 533-3646 Fax: (808) 526-1267

Major Street: Poipu Road
Minor Street: Ala Kinoiki Road
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : POIALAPM
Site Code : 00000000
Start Date : 06/03/2003

Groups Printed- vehicles

	POIPU ROAD Southbound					ALA KINOIKI ROAD Westbound					POIPU ROAD Northbound					PEE ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:30 PM	11	11	10	0	32	6	7	10	0	23	13	14	3	0	30	3	10	5	0	18	103
03:45 PM	9	21	17	0	47	33	13	21	0	67	26	28	4	0	58	6	22	9	0	37	209
Total	20	32	27	0	79	39	20	31	0	90	39	42	7	0	88	9	32	14	0	55	312
04:00 PM	10	21	26	0	57	29	24	19	0	72	44	23	3	0	70	3	34	14	0	51	250
04:15 PM	17	22	14	0	53	17	12	14	0	43	21	24	8	0	53	10	14	10	0	34	183
04:30 PM	19	22	40	0	81	28	10	19	0	57	21	23	6	0	50	9	26	21	0	56	244
04:45 PM	16	26	26	0	68	25	18	26	0	69	19	16	4	0	39	4	19	11	0	34	210
Total	62	91	106	0	259	99	64	78	0	241	105	86	21	0	212	26	93	56	0	175	887
05:00 PM	11	13	23	0	47	27	18	18	0	63	49	31	5	0	85	8	31	11	0	50	245
05:15 PM	17	20	20	0	57	29	14	12	0	55	21	27	6	0	54	5	25	11	0	41	207
Grand Total	110	156	176	0	442	194	116	139	0	449	214	186	39	0	439	48	181	92	0	321	1651
Apprch %	24.9	35.3	39.8	0.0		43.2	25.8	31.0	0.0		48.7	42.4	8.9	0.0		15.0	56.4	28.7	0.0		
Total %	6.7	9.4	10.7	0.0	26.8	11.8	7.0	8.4	0.0	27.2	13.0	11.3	2.4	0.0	26.6	2.9	11.0	5.6	0.0	19.4	

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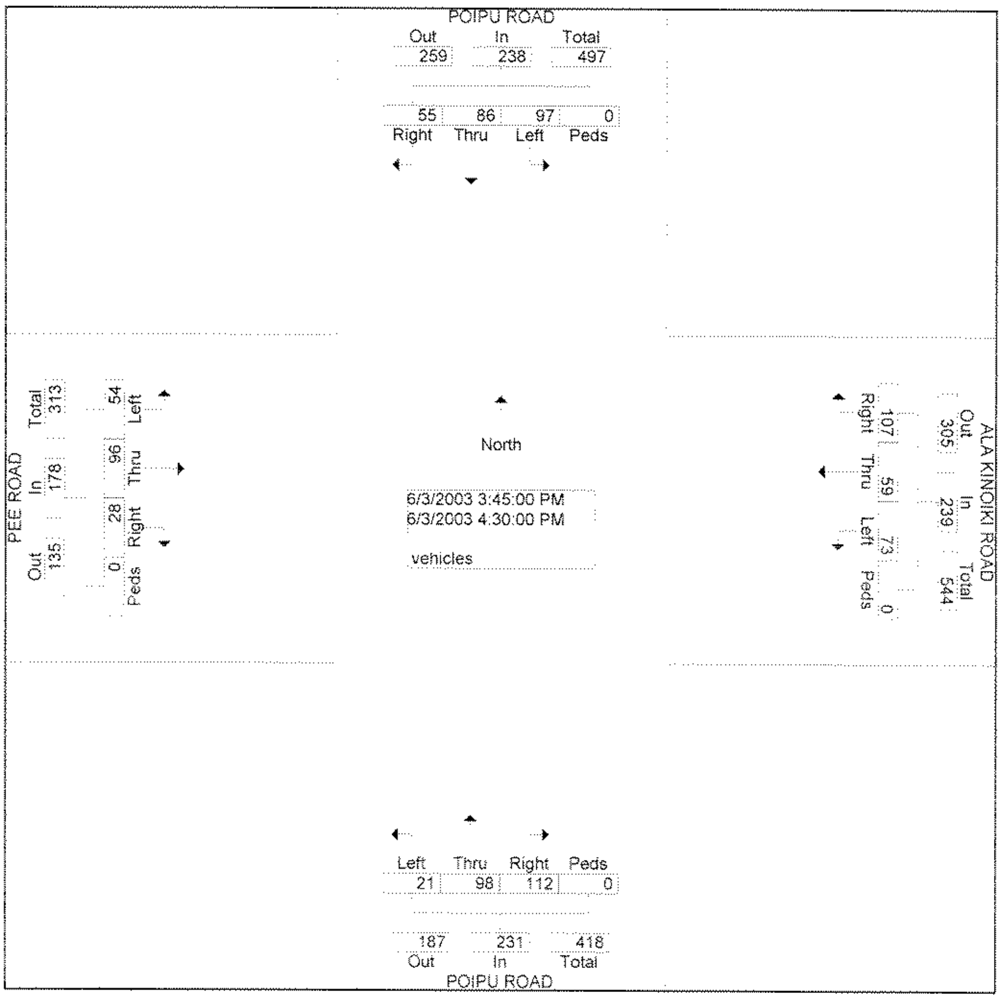
Major Street: Poipu Road
Minor Street: Ala Kinoiki Road
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : POIALAPM
Site Code : 00000000
Start Date : 06/03/2003

	POIPU ROAD Southbound					ALA KINOIKI ROAD Westbound					POIPU ROAD Northbound					PEE ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 03:45 PM to 04:30 PM - Peak 1 of 1																					
Intersection	03:45 PM																				
Volume	55	86	97	0	238	107	59	73	0	239	112	98	21	0	231	28	96	54	0	178	886
Percent	23.1	36.1	40.8	0.0		44.8	24.7	30.5	0.0		48.5	42.4	9.1	0.0		15.7	53.9	30.3	0.0		
04:00 Volume	10	21	26	0	57	29	24	19	0	72	44	23	3	0	70	3	34	14	0	51	250
Peak Factor																					0.886
High Int.	04:30 PM					04:00 PM					04:00 PM					04:30 PM					
Volume	19	22	40	0	81	29	24	19	0	72	44	23	3	0	70	9	26	21	0	56	
Peak Factor					0.735					0.830					0.825					0.795	



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Major Street: Poipu Road
Minor Street: Kipuka Street
Time of Count: 6:30 AM-8:30 AM
Weather

File Name : POIKIPAM
Site Code : 00000000
Start Date : 06/04/2003
Page No : 1

Groups Printed- vehicles

	POIPU ROAD Southbound					KIPUKA STREET Westbound					POIPU ROAD Northbound					KIPUKA STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 AM	0	19	1	0	20	3	0	5	0	8	1	7	0	0	8	0	0	0	0	0	36
06:45 AM	0	20	1	0	21	5	0	4	0	9	1	22	0	0	23	0	0	0	0	0	53
Total	0	39	2	0	41	8	0	9	0	17	2	29	0	0	31	0	0	0	0	0	89
07:00 AM	0	25	2	0	27	6	0	7	0	13	3	17	0	0	20	0	0	0	0	0	60
07:15 AM	0	21	4	0	25	4	0	7	0	11	2	37	0	0	39	0	0	0	0	0	75
07:30 AM	0	21	2	0	23	9	0	3	3	15	1	32	0	0	33	0	0	0	0	0	71
07:45 AM	0	27	6	0	33	6	0	3	0	9	1	27	0	0	28	0	0	0	0	0	70
Total	0	94	14	0	108	25	0	20	3	48	7	113	0	0	120	0	0	0	0	0	276
08:00 AM	0	34	6	0	40	1	0	5	1	7	5	27	0	0	32	0	0	0	0	0	79
08:15 AM	0	34	2	0	36	2	0	6	1	9	2	24	0	0	26	0	0	0	0	0	71
Grand Total	0	201	24	0	225	36	0	40	5	81	16	193	0	0	209	0	0	0	0	0	515
Apprch %	0.0	89.3	10.7	0.0		44.4	0.0	49.4	6.2		7.7	92.3	0.0	0.0		0.0	0.0	0.0	0.0		
Total %	0.0	39.0	4.7	0.0	43.7	7.0	0.0	7.8	1.0	15.7	3.1	37.5	0.0	0.0	40.6	0.0	0.0	0.0	0.0	0.0	

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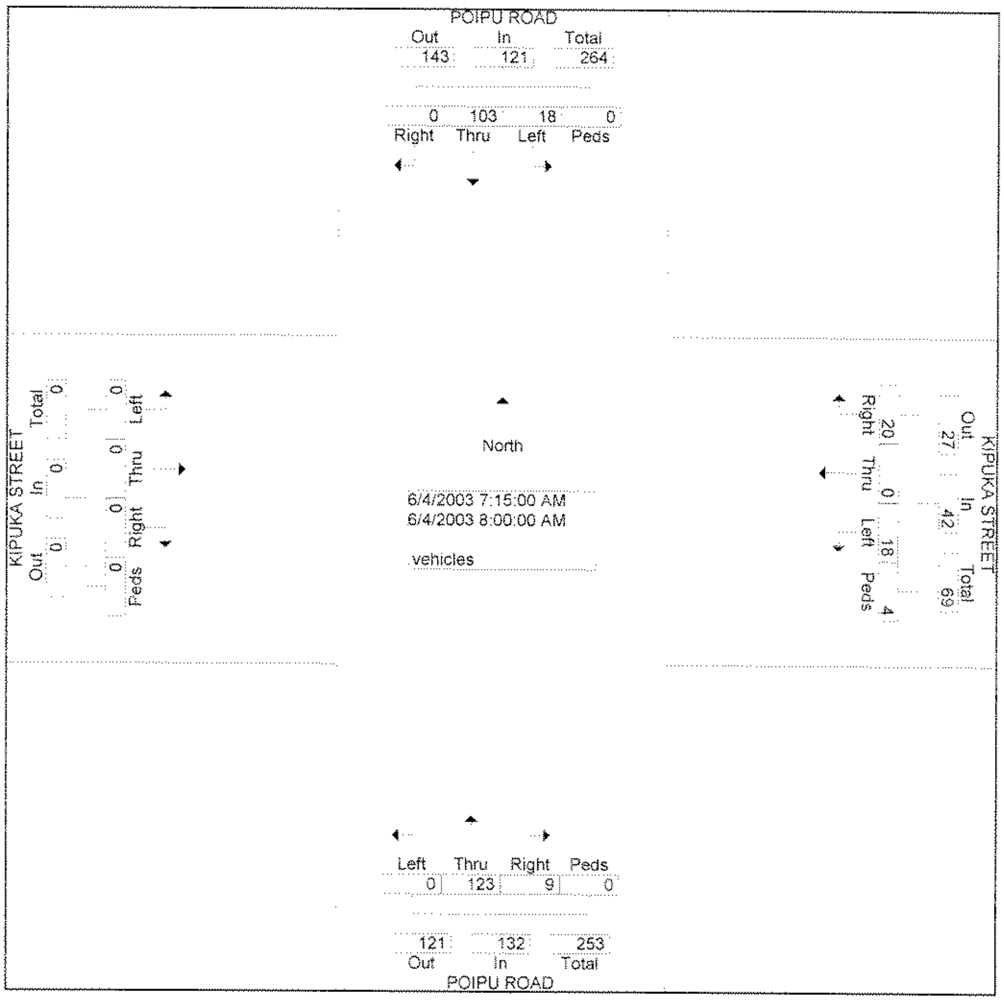
Major Street: Poipu Road
Minor Street: Kipuka Street
Time of Count: 6:30 AM-8:30 AM
Weather

File Name : POIKIPAM
Site Code : 00000000
Start Date : 06/04/2003

	POIPU ROAD Southbound					KIPUKA STREET Westbound					POIPU ROAD Northbound					KIPUKA STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 12:30 AM to 08:15 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	0	103	18	0	121	20	0	18	4	42	9	123	0	0	132	0	0	0	0	0	295
Percent	0.0	85.1	14.9	0.0		47.6	0.0	42.9	9.5		6.8	93.2	0.0	0.0		0.0	0.0	0.0	0.0		
08:00 Volume	0	34	6	0	40	1	0	5	1	7	5	27	0	0	32	0	0	0	0	0	79
Peak Factor																					0.934
High Int.	08:00 AM					07:30 AM					07:15 AM					12:15:00 AM					
Volume	0	34	6	0	40	9	0	3	3	15	2	37	0	0	39						
Peak Factor					0.756					0.700					0.846						



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Major Street: Poipu Road
Minor Street: Kipuka Street
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : POIKIPPM
Site Code : 00000000
Start Date : 06/03/2003

Groups Printed- vehicles

	POIPU ROAD Southbound					KIPUKA STREET Westbound					POIPU ROAD Northbound					KIPUKA STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:30 PM	0	23	0	0	23	0	0	1	0	1	3	16	0	0	19	0	0	0	0	0	43
03:45 PM	0	47	5	0	52	3	0	0	0	3	5	60	0	0	65	0	0	0	0	0	120
Total	0	70	5	0	75	3	0	1	0	4	8	76	0	0	84	0	0	0	0	0	163
04:00 PM	0	58	2	0	60	4	0	5	2	11	6	60	0	0	66	0	0	0	0	0	137
04:15 PM	0	55	10	0	65	6	0	6	1	13	2	53	0	1	56	0	0	0	0	0	134
04:30 PM	0	71	8	0	79	3	0	8	0	11	6	65	0	0	71	0	0	0	0	0	161
04:45 PM	0	64	5	0	69	2	0	2	0	4	6	41	0	0	47	0	0	0	0	0	120
Total	0	248	25	0	273	15	0	21	3	39	20	219	0	1	240	0	0	0	0	0	552
05:00 PM	0	47	7	0	54	4	0	3	0	7	9	50	0	2	61	0	0	0	0	0	122
05:15 PM	0	44	7	0	51	4	0	2	0	6	4	58	0	0	62	0	0	0	0	0	119
Grand Total	0	409	44	0	453	26	0	27	3	56	41	403	0	3	447	0	0	0	0	0	956
Apprch %	0.0	90.3	9.7	0.0		46.4	0.0	48.2	5.4		9.2	90.2	0.0	0.7		0.0	0.0	0.0	0.0		
Total %	0.0	42.8	4.6	0.0	47.4	2.7	0.0	2.8	0.3	5.9	4.3	42.2	0.0	0.3	46.8	0.0	0.0	0.0	0.0	0.0	

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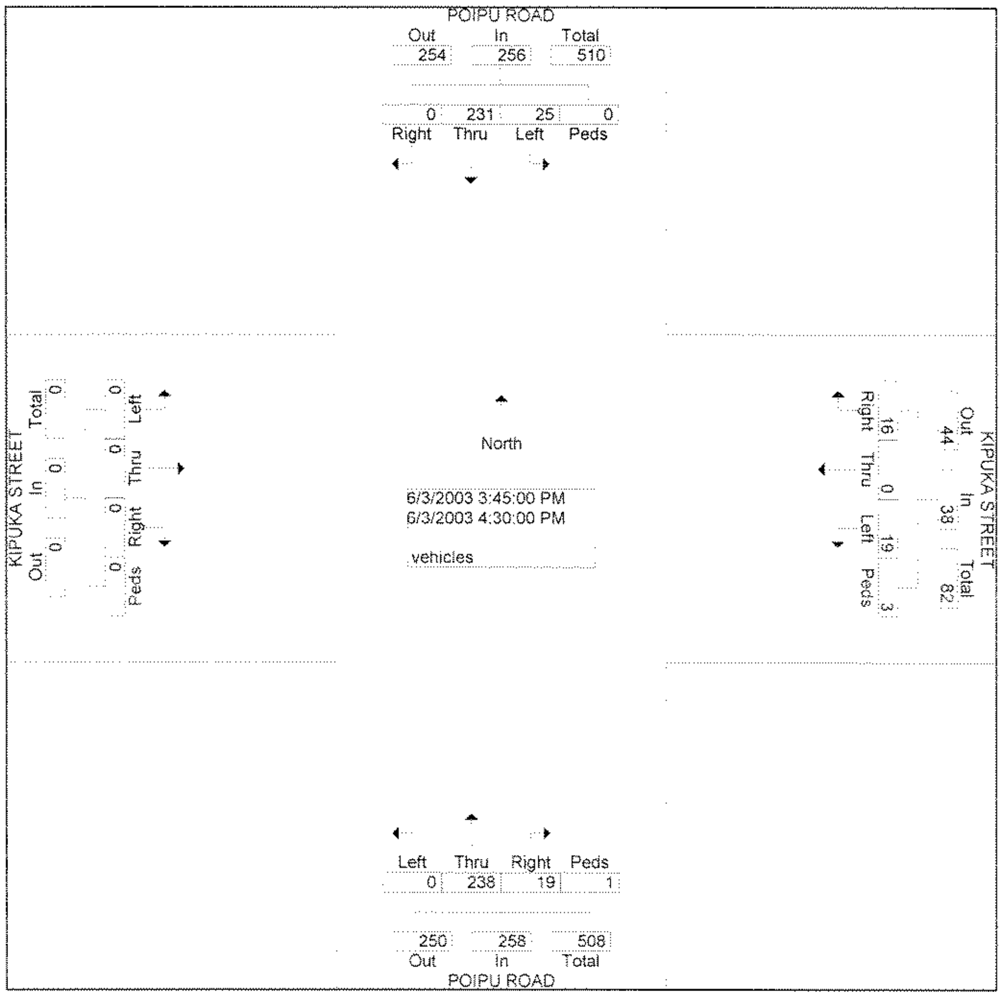
Major Street: Poipu Road
Minor Street: Kipuka Street
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : POIKIPPM
Site Code : 00000000
Start Date : 06/03/2003

	POIPU ROAD Southbound					KIPUKA STREET Westbound					POIPU ROAD Northbound					KIPUKA STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 03:30 PM to 05:15 PM - Peak 1 of 1																					
Intersection	03:45 PM																				
Volume	0	231	25	0	256	16	0	19	3	38	19	238	0	1	258	0	0	0	0	0	552
Percent	0.0	90.2	9.8	0.0		42.1	0.0	50.0	7.9		7.4	92.2	0.0	0.4		0.0	0.0	0.0	0.0		
04:30 Volume	0	71	8	0	79	3	0	8	0	11	6	65	0	0	71	0	0	0	0	0	161
Peak Factor																					0.857
High Int.	04:30 PM					04:15 PM					04:30 PM					3:15:00 PM					
Volume	0	71	8	0	79	6	0	6	1	13	6	65	0	0	71						
Peak Factor					0.810					0.731					0.908						



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Major Street: Poipu Road
Minor Street: Hoowili Road
Time of Count: 7:15 - 8:15 AM
Weather: Sunny

File Name : poihooam
Site Code : 00000000
Start Date : 08/21/2003
Page No : 1

Groups Printed- Unshifted

	HOOWILI ROAD Southbound					POIPU ROAD Westbound					HOOWILI ROAD Northbound					POIPU ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	4	4	0	32	7	0	39	3	0	10	4	17	24	18	0	0	42	102
07:30 AM	0	0	0	0	0	1	33	3	0	37	4	0	18	3	25	12	25	0	0	37	99
07:45 AM	0	0	0	0	0	0	32	7	0	39	5	0	10	1	16	15	32	0	0	47	102
Total	0	0	0	4	4	1	97	17	0	115	12	0	38	8	58	51	75	0	0	126	303
08:00 AM	0	0	0	0	0	0	26	6	0	32	5	0	14	3	22	24	19	0	0	43	97
08:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	0	4	4	1	123	23	0	147	17	0	52	11	80	75	94	0	0	169	400
Apprch %	0.0	0.0	0.0	100.0		0.7	83.7	15.6	0.0		21.3	0.0	65.0	13.8		44.4	55.6	0.0	0.0		
Total %	0.0	0.0	0.0	1.0	1.0	0.3	30.8	5.8	0.0	36.8	4.3	0.0	13.0	2.8	20.0	18.8	23.5	0.0	0.0	42.3	

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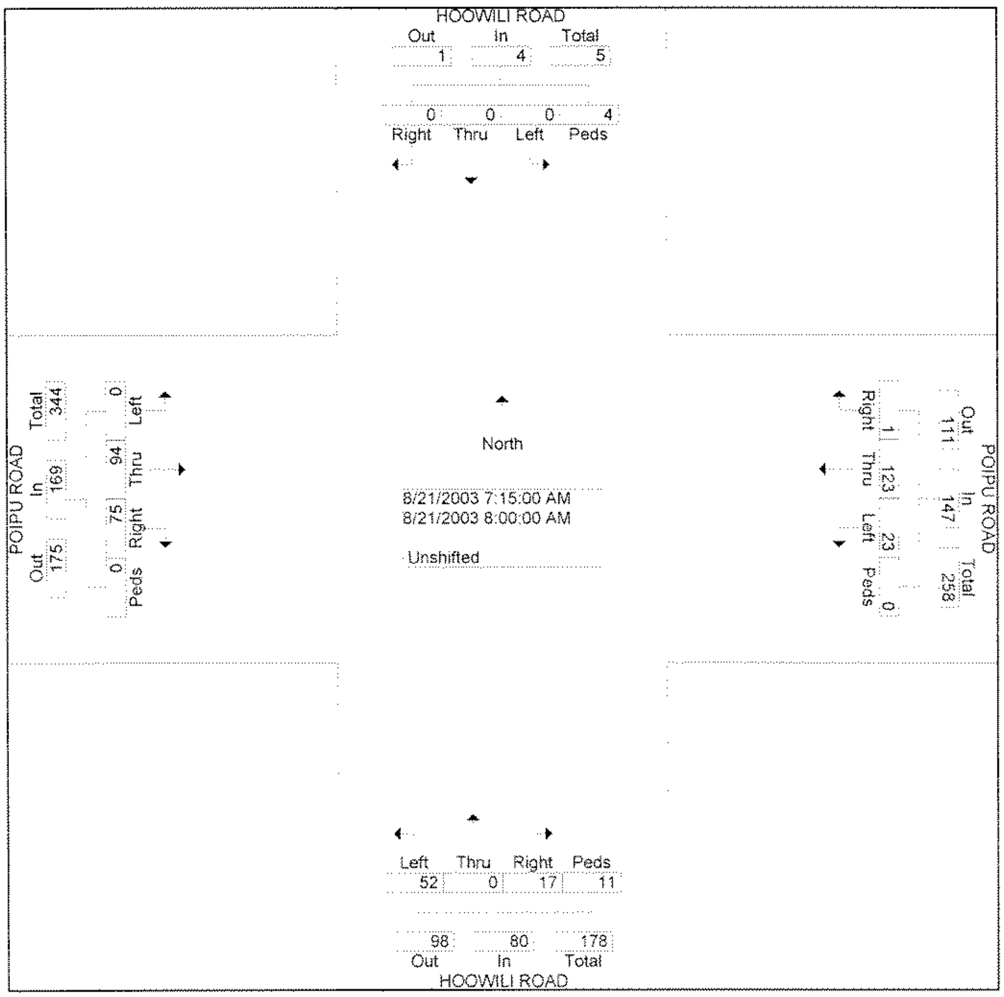
Major Street: Poipu Road
Minor Street: Hoowili Road
Time of Count: 7:15 - 8:15 AM
Weather: Sunny

File Name : poihooam
Site Code : 00000000
Start Date : 08/21/2003

	HOOWILI ROAD Southbound					POIPU ROAD Westbound					HOOWILI ROAD Northbound					POIPU ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 06:45 AM to 08:15 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	0	0	0	4	4	1	123	23	0	147	17	0	52	11	80	75	94	0	0	169	400
Percent	0.0	0.0	0.0	100.0		0.7	83.7	15.6	0.0		21.3	0.0	65.0	13.8		44.4	55.6	0.0	0.0		
07:45 Volume	0	0	0	0	0	0	32	7	0	39	5	0	10	1	16	15	32	0	0	47	102
Peak Factor																					0.980
High Int.	07:15 AM					07:15 AM					07:30 AM					07:45 AM					
Volume	0	0	0	4	4	0	32	7	0	39	4	0	18	3	25	15	32	0	0	47	
Peak Factor					0.250					0.942					0.800					0.899	



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Major Street: Poipu Road
Minor Street: Hoowili Road
Time of Count: 3:45-4:45 PM
Weather: Sunny

File Name : poihoopm
Site Code : 00000000
Start Date : 08/20/2003
Page No : 1

Groups Printed- Unshifted

	HOOWILI ROAD Southbound					POIPU ROAD Westbound					HOOWILI ROAD Northbound					POIPU ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:45 PM	0	0	0	0	0	0	55	13	0	68	14	0	30	0	44	23	48	0	0	71	183
Total	0	0	0	0	0	0	55	13	0	68	14	0	30	0	44	23	48	0	0	71	183
04:00 PM	0	0	0	0	0	0	49	11	0	60	13	0	16	0	29	32	58	0	0	90	179
04:15 PM	0	0	0	0	0	0	38	9	0	47	15	0	36	0	51	40	61	0	0	101	199
04:30 PM	0	0	0	0	0	0	58	10	0	68	17	0	37	1	55	29	58	0	0	87	210
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	145	30	0	175	45	0	89	1	135	101	177	0	0	278	588
05:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	0	0	0	0	0	0	200	43	0	243	59	0	119	1	179	124	225	0	0	349	771
Apprch %	0.0	0.0	0.0	0.0		0.0	82.3	17.7	0.0		33.0	0.0	66.5	0.6		35.5	64.5	0.0	0.0		
Total %	0.0	0.0	0.0	0.0	0.0	0.0	25.9	5.6	0.0	31.5	7.7	0.0	15.4	0.1	23.2	16.1	29.2	0.0	0.0	45.3	

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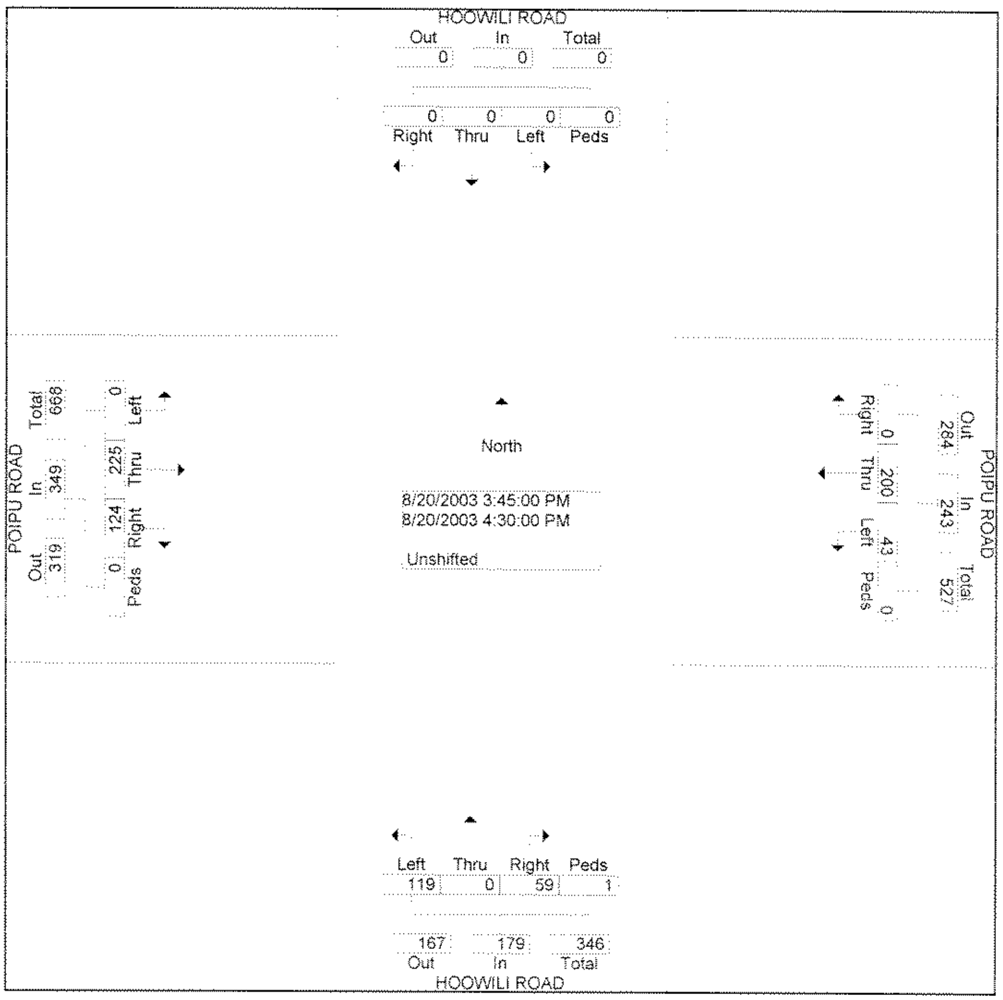
Major Street: Poipu Road
Minor Street: Hoowili Road
Time of Count: 3:45-4:45 PM
Weather: Sunny

File Name : poihoopm
Site Code : 00000000
Start Date : 08/20/2003

	HOOWILI ROAD Southbound					POIPU ROAD Westbound					HOOWILI ROAD Northbound					POIPU ROAD Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 03:45 PM to 05:00 PM - Peak 1 of 1																					
Intersection	03:45 PM																				
Volume	0	0	0	0	0	0	200	43	0	243	59	0	119	1	179	124	225	0	0	349	771
Percent	0.0	0.0	0.0	0.0		0.0	82.3	17.7	0.0		33.0	0.0	66.5	0.6		35.5	64.5	0.0	0.0		
04:30 Volume	0	0	0	0	0	0	58	10	0	68	17	0	37	1	55	29	58	0	0	87	210
Peak Factor																					0.918
High Int.	3:30:00 PM					03:45 PM					04:30 PM					04:15 PM					
Volume	0	0	0	0	0	0	55	13	0	68	17	0	37	1	55	40	61	0	0	101	
Peak Factor										0.893					0.814					0.864	



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501 Sumner Street, Suite 521
Honolulu, Hawaii 96817
Ph: (808) 533-3646 Fax: (808) 526-1267

major Street: Poipu Road
Minor street: Kiahuna Plantation Drive
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : POIKIAAM
Site Code : 00000000
Start Date : 06/04/2003

Groups Printed- vehicles

	POIPU ROAD Southbound					KIAHUNA PLANTATION DRIVE Westbound					POIPU ROAD Northbound					KIAHUNA PLANTATION DRIVE Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
06:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 AM	1	23	4	0	28	4	0	2	0	6	1	11	0	0	12	0	0	2	1	3	49
06:45 AM	3	37	7	0	47	1	1	0	0	2	4	24	0	0	28	2	0	3	1	6	83
Total	4	60	11	0	75	5	1	2	0	8	5	35	0	0	40	3	0	5	2	10	133
07:00 AM	3	41	6	0	50	2	1	3	0	6	6	27	1	2	36	0	1	0	1	2	94
07:15 AM	3	42	4	0	49	4	0	1	0	5	6	31	1	0	38	1	0	0	1	2	94
07:30 AM	8	43	10	0	61	7	0	4	0	11	4	32	2	1	39	1	0	1	1	3	114
07:45 AM	10	59	14	0	83	9	0	10	0	19	10	16	1	0	27	1	1	1	0	3	132
Total	24	185	34	0	243	22	1	18	0	41	26	106	5	3	140	3	2	2	3	10	434
08:00 AM	3	45	16	0	64	6	1	8	0	15	9	34	1	0	44	1	0	1	0	2	125
08:15 AM	4	37	13	0	54	7	0	6	0	13	6	27	2	0	35	1	2	3	0	6	108
Grand Total	35	327	74	0	436	40	3	34	0	77	46	202	8	3	259	8	4	11	5	28	800
Apprch %	8.0	75.0	17.0	0.0		51.9	3.9	44.2	0.0		17.8	78.0	3.1	1.2		28.6	14.3	39.3	17.9		
Total %	4.4	40.9	9.3	0.0	54.5	5.0	0.4	4.3	0.0	9.6	5.8	25.3	1.0	0.4	32.4	1.0	0.5	1.4	0.6	3.5	

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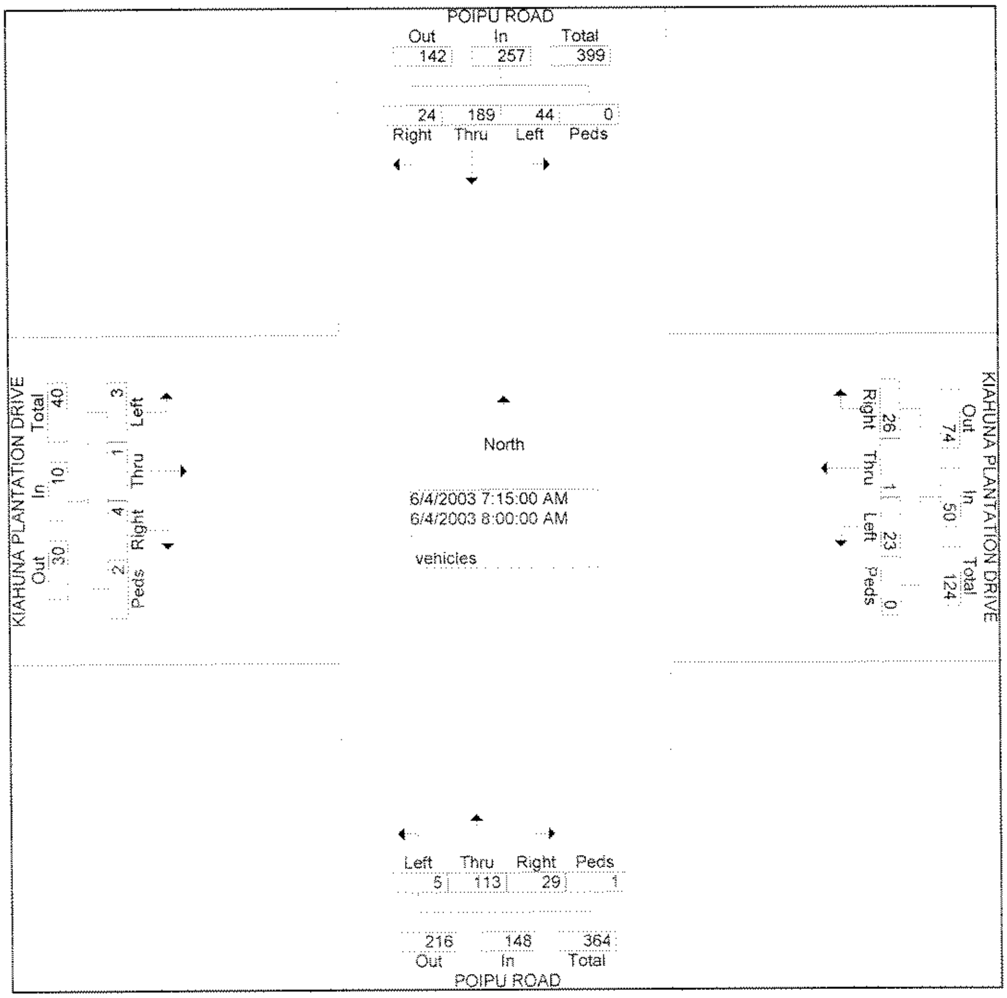
Time of Count: 6:30 AM-8:30 AM
Weather:

File Name : POIKIAAM
Site Code : 00000000
Start Date : 06/04/2003

	POIPU ROAD Southbound					KIAHUNA PLANTATION DRIVE Westbound					POIPU ROAD Northbound					KIAHUNA PLANTATION DRIVE Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 07:15 AM to 08:00 AM - Peak 1 of 1																					
Intersection	07:15 AM																				
Volume	24	189	44	0	257	26	1	23	0	50	29	113	5	1	148	4	1	3	2	10	465
Percent	9.3	73.5	17.1	0.0		52.0	2.0	46.0	0.0		19.6	76.4	3.4	0.7		40.0	10.0	30.0	20.0		
07:45 Volume	10	59	14	0	83	9	0	10	0	19	10	16	1	0	27	1	1	1	0	3	132
Peak Factor																					0.881
High Int.	07:45 AM					07:45 AM					08:00 AM					07:30 AM					
Volume	10	59	14	0	83	9	0	10	0	19	9	34	1	0	44	1	0	1	1	3	
Peak Factor					0.774					0.658					0.841					0.833	



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Ph: (808) 533-3646 Fax: (808) 526-1267

Major Street: Poipu Road
Minor Street: Kiahuna Plantation Drive
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : POIKIAPM
Site Code : 00000000
Start Date : 06/03/2003
Page No : 1

Groups Printed- vehicles

	POIPU ROAD Southbound					KIAHUNA PLANTATION DRIVE Westbound					POIPU ROAD Northbound					KIAHUNA PLANTATION DRIVE Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:30 PM	1	0	0	1	2	0	1	1	1	3	0	0	0	0	0	0	1	1	0	2	7
03:45 PM	5	55	19	0	79	18	0	11	0	29	16	51	4	4	75	2	0	4	0	6	189
Total	6	55	19	1	81	18	1	12	1	32	16	51	4	4	75	2	1	5	0	8	196
04:00 PM	2	62	26	0	90	25	3	11	0	39	18	78	4	7	107	2	1	10	0	13	249
04:15 PM	3	60	23	0	86	28	1	14	0	43	23	51	3	0	77	6	1	1	0	8	214
04:30 PM	7	65	15	0	87	24	2	16	0	42	19	82	2	2	105	5	2	10	0	17	251
04:45 PM	7	70	25	0	102	16	0	15	0	31	16	59	2	2	79	3	0	3	1	7	219
Total	19	257	89	0	365	93	6	56	0	155	76	270	11	11	368	16	4	24	1	45	933
05:00 PM	5	63	17	0	85	13	0	6	0	19	15	55	5	5	80	2	1	9	4	16	200
05:15 PM	5	63	26	0	94	24	1	5	0	30	18	72	2	2	94	2	1	3	0	6	224
Grand Total	35	438	151	1	625	148	8	79	1	236	125	448	22	22	617	22	7	41	5	75	1553
Apprch %	5.6	70.1	24.2	0.2		62.7	3.4	33.5	0.4		20.3	72.6	3.6	3.6		29.3	9.3	54.7	6.7		
Total %	2.3	28.2	9.7	0.1	40.2	9.5	0.5	5.1	0.1	15.2	8.0	28.8	1.4	1.4	39.7	1.4	0.5	2.6	0.3	4.8	

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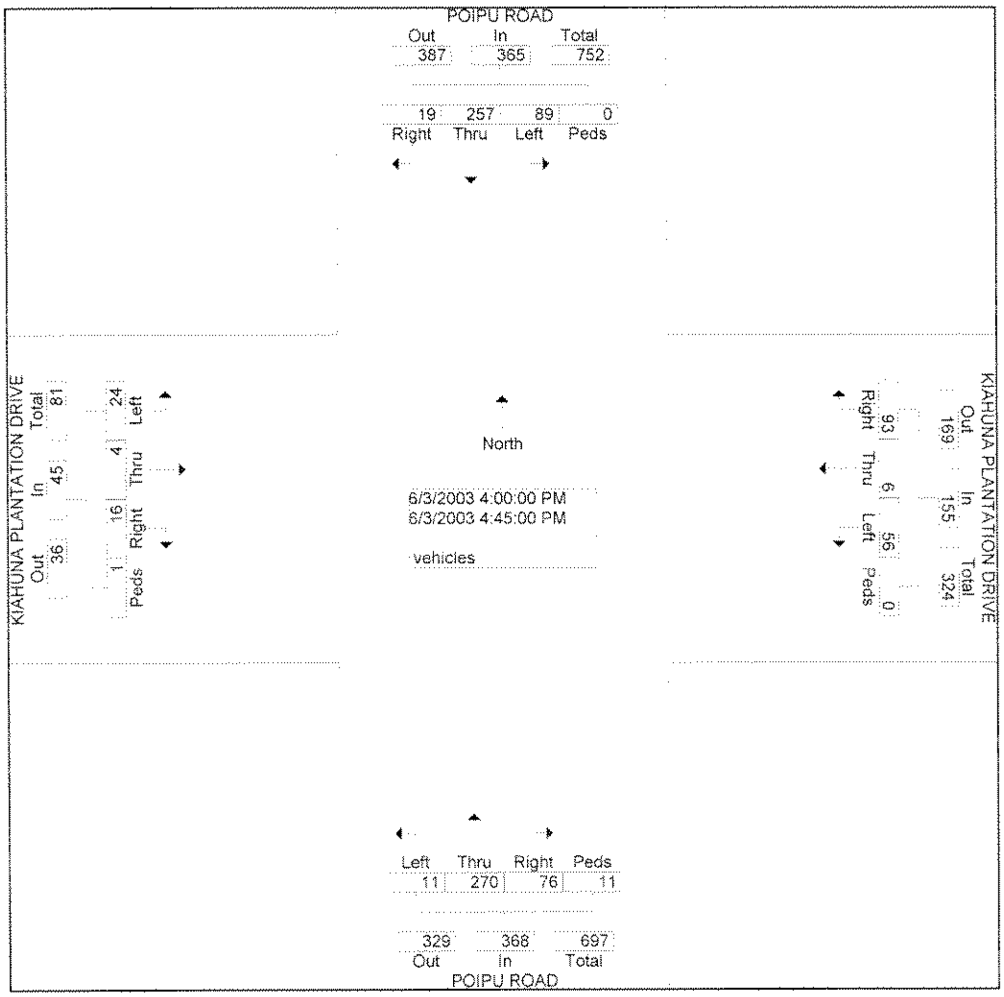
Major Street: Poipu Road
Minor Street: Kiahuna Plantation Drive
Time of Count: 3:30 PM-5:30 PM
Weather:

File Name : POIKIAPM
Site Code : 00000000
Start Date : 06/03/2003

	POIPU ROAD Southbound					KIAHUNA PLANTATION DRIVE Westbound					POIPU ROAD Northbound					KIAHUNA PLANTATION DRIVE Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Intersection	04:00 PM																				
Volume	19	257	89	0	365	93	6	56	0	155	76	270	11	11	368	16	4	24	1	45	933
Percent	5.2	70.4	24.4	0.0		60.0	3.9	36.1	0.0		20.7	73.4	3.0	3.0		35.6	8.9	53.3	2.2		
04:30 Volume	7	65	15	0	87	24	2	16	0	42	19	82	2	2	105	5	2	10	0	17	251
Peak Factor																					0.929
High Int.	04:45 PM					04:15 PM					04:00 PM					04:30 PM					
Volume	7	70	25	0	102	28	1	14	0	43	18	78	4	7	107	5	2	10	0	17	
Peak Factor					0.895					0.901					0.860					0.662	



APPENDIX B

LEVEL OF SERVICE CRITERIA

LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS (HCM 2000)

The level of service criteria for unsignalized intersections is defined as the average total delay, in seconds per vehicle. As used here, total delay is defined as the total elapsed time from when a vehicle stops at the end of the queue until the vehicle departs from the stop line; this time includes the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position. While the criteria for level of service for two-way-stop-controlled (TWSC) and all-way-stop-controlled (AWSC) intersections are the same, procedures to calculate the average total delay may differ.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Total Delay (sec/veh)
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

LEVEL OF SERVICE CRITERIA FOR ALL-WAY STOP-CONTROLLED INTERSECTIONS (HCM 2000)

The all-way stop-controlled intersection is a special type of unsignalized intersection, where vehicles on all approaches are required to stop before entering the intersection. Generally, the sequence of entry into the intersection is on a "first come, first serve basis", according to order of arrival at the intersection. In theory, if vehicles arrive at two or more of the approaches at the same time, then according the "rules of the road", the vehicle to the right is allowed to proceed first. However, it has been observed that two-lane AWSC intersections often operate on a virtual 2-phase patterns, where North-South streams alternate right-of-way with East-West streams. Multilane AWSC intersections generally operate in 4 phases, where each approach will take up a single phase. The table, shown below, identifies the Level of Service and corresponding average stopped delay for all-way stop-controlled intersections.

Level of Service Criteria for AWSC Intersections

Level of Service	Average Total Delay (sec/veh)
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 2000)

Level of service for signalized intersections is directly related to delay values and is assigned on that basis. Level of Service is a measure of the acceptability of delay values to motorists at a given intersection. The criteria are given in table below.

Level-of Service Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (sec./veh.)
A	< 10.0
B	>10.0 and ≤20.0
C	>20.0 and ≤35.0
D	>35.0 and ≤55.0
E	>55.0 and ≤80.0
F	> 80.0

Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group or approach in question.

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Existing

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	POIPU ROAD
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		210	204	155	62		87		96			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		233	227	172	69		97		107			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	107	694	.154	1	11.1	B	16.1
	2	L	97	314	.309	1	21.5	C	
	3								C
SB	1								
	2								
	3								
		1							
		4	172	1096	.157	1	8.9	A	

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CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK 2003	Minor Street	POIPU ROAD
Comment	EXISTING		

Input Data

Lane Configuration	EB			WB			NB			SB		
Lane 1 (curb)	TR			T			R					
Lane 2				L			L					
Lane 3												
	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		190	208	269	240		194		255			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		211	231	299	267		216		283			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	283	712	.397	2	13.3	B	130.6
	2	L	216	151	1.433	14	284.2	F	
	3								F
SB	1								
	2								
	3								
		1							
		4	299	1113	.269	1	9.4	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	MALUHIA ROAD
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	87	244			106	42				42		123
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	97	271			118	47				47		137
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	137	904	.152	1	9.7	A	10.9
	2	L	47	427	.11	<1	14.5	B	
	3								B
		1	97	1408	.069	<1	7.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	BK
Agency or Company	ATA
Analysis Period/Year	PM PEAK 2003
Comment	EXISTING

Site Information

Jurisdiction/Date	POIPU 8/12/2003
Major Street	KOLOA ROAD
Minor Street	MALUHIA ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	206	296			344	63				68		204
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	229	329			382	70				76		227
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	227	633	.358	2	13.8	B	21.9
	2	L	76	160	.474	2	46.2	E	
	3								C
		1	229	1103	.208	1	9.1	A	
		4							

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CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	ALA KINO IKI
Comment	EXISTING		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		112	1	119	158		0		114			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		124	1	132	176		0		127			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	127	924	.138	<1	9.5	A	9.5
	2	L				<1			
	3								A
EB	1								
	2								
	3								
		1							
		4	132	1455	.091	<1	7.7	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: BK
Agency or Company: ATA
Analysis Period/Year: PM PEAK 2003
Comment: EXISTING

Site Information

Jurisdiction/Date: POIPU 9/5/2003
Major Street: MALUHIA ROAD
Minor Street: ALA KINO IKI

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		205	8	193	237		13		208			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		228	9	214	263		14		231			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ________ ft   Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	231	809	.286	1	11.2	B	11.7
	2	L	14	251	.056	<1	20.2	C	
	3								B
EB	1								
	2								
	3								
		1							
		4	214	1325	.162	1	8.2	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	WELIWELI ROAD
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		223	141	39	6		10		175			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		248	157	43	7		11		194			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	205	703	.292	1	12.2	B	12.2 B
	2								
	3								
SB	1								
	2								
	3								
		1							
		4	43	1149	.038	<1	8.3	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: BK
Agency or Company: ATA
Analysis Period/Year: PM PEAK 2003
Comment: EXISTING

Site Information

Jurisdiction/Date: POIPU 8/12/2003
Major Street: KOLOA ROAD
Minor Street: WELIWELI ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		285	102	19	293		39		6			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		317	113	21	326		43		7			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft   Movement 5 ______ ft
Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	50	400	.125	<1	15.3	C	15.3
	2								
	3								C
SB	1								
	2								
	3								
		1							
		4	21	1124	.019	<1	8.3	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	HAPA ROAD
Comment	EXISTING		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	0	53			172	3				8		6
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	0	59			191	3				9		7
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	7	846	.008	<1	9.3	A	9.7
	2	L	9	735	.012	<1	10	A	
	3								A
		1	0	1373	0	<1	7.6	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	BK
Agency or Company	ATA
Analysis Period/Year	PM PEAK 2003
Comment	EXISTING

Site Information

Jurisdiction/Date	POIPU 8/12/2003
Major Street	WELIWELI ROAD
Minor Street	HAPA ROAD

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	1	142			91	10				5		1
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	1	158			101	11				6		1
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	1	945	.001	<1	8.8	A	9.9
	2	L	6	720	.008	<1	10	A	
	3								A
		1	1	1471	.001	<1	7.4	A	
		4							

HiCAP 2000 ™

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	AM PEAK 2003	Minor Street	WELIWELI ROAD
Comment	EXISTING		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	45	113	1	4	136	2	0	5	5	2	20	155
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	50	126	1	4	151	2	0	6	6	2	22	172
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	LTR	12	668	.018	<1	10.5	B	10.5
	2								
	3								B
EB	1	LTR	196	821	.239	1	10.8	B	10.8
	2								
	3								B
		1	50	1421	.035	<1	7.6	A	
		4	4	1453	.003	<1	7.5	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: BK
Agency or Company: ATA
Analysis Period/Year: PM PEAK 2003
Comment: EXISTING

Site Information

Jurisdiction/Date: POIPU 8/12/2003
Major Street: ALA KINO IKI
Minor Street: WELIWELI ROAD

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	125	206	7	6	168	1	5	20	8	2	11	83
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	139	229	8	7	187	1	6	22	9	2	12	92
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	LTR	37	357	.104	<1	16.3	C	16.3
	2								
	3								C
EB	1	LTR	106	695	.153	1	11.1	B	11.1
	2								
	3								B
		1	139	1380	.101	<1	7.9	A	
		4	7	1325	.005	<1	7.7	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	BK
Agency or Company	ATA
Analysis Period/Year	AM PEAK 2003
Comment	EXISTING

Site Information

Jurisdiction/Date	POIPU	8/12/2003
Major Street	POIPU ROAD	
Minor Street	EASTERN BYPASS	

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	R	LTR	R
Lane 2	L	LT		LT
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	51	44	42	6	25	28	39	54	8	133	98	80
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	57	49	47	7	28	31	43	60	9	148	109	89
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	112	566	.198	1	12.9	B	12.9
	2								
	3								B
SB	1	R	89	1045	.085	<1	8.8	A	13.3
	2	LT	257	618	.416	2	14.9	B	
	3								B
		1	57	1539	.037	<1	7.4	A	
		4	7	1492	.004	<1	7.4	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	BK
Agency or Company	ATA
Analysis Period/Year	PM PEAK 2003
Comment	EXISTING

Site Information

Jurisdiction/Date	POIPU 8/12/2003
Major Street	POIPU ROAD
Minor Street	EASTERN BYPASS

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	R	LTR	R
Lane 2	L	LT		LT
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	97	86	55	21	98	112	54	96	28	73	59	107
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	108	96	61	23	109	124	60	107	31	81	66	119
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	198	359	.551	3	26.6	D	26.6 D
	2								
	3								
SB	1	R	119	942	.126	<1	9.4	A	17 C
	2	LT	147	342	.43	2	23.3	C	
	3								
		1	108	1328	.081	<1	7.9	A	
		4	23	1417	.016	<1	7.6	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	KIPUKA STREET
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	18	103			123	9				18		20
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	20	114			137	10				20		22
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	42	783	.054	<1	9.9	A	9.9
	2								
	3								A
		1	20	1429	.014	<1	7.6	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK 2003	Minor Street	KIPUKA STREET
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	25	231			238	19				19		16
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	28	257			264	21				21		18
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	39	563	.069	<1	11.9	B	11.9
	2								
	3								B
		1	28	1271	.022	<1	7.9	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	EV	Jurisdiction/Date	POIPU 8/25/2003
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	HOOWILI ROAD
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		123	75	23	108		52		17			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		137	83	26	120		58		19			
Flare storage (# of vehs)									0			
Median storage (# of vehs)								0				

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	19	862	.022	<1	9.3	A	10.8
	2	L	58	633	.092	<1	11.3	B	
	3								B
SB	1								
	2								
	3								
		1							
		4	26	1343	.019	<1	7.7	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	EV
Agency or Company	ATA
Analysis Period/Year	PM PEAK 2003
Comment	EXISTING

Site Information

Jurisdiction/Date	POIPU 8/25/2003
Major Street	POIPU ROAD
Minor Street	HOOWILI ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		191	124	43	220		119		59			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		212	138	48	244		132		66			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	66	755	.087	<1	10.2	B	14.7
	2	L	132	431	.306	1	17	C	
	3								B
SB	1								
	2								
	3								
		1							
		4	48	1203	.04	<1	8.1	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: EV
Agency or Company: ATA
Analysis Period/Year: AM PEAK HOUR 2003
Comment: EXISTING

Site Information

Jurisdiction/Date: POIPU 10/14/200
Major Street: POIPU ROAD
Minor Street: KIAHUNA TENNIS CLUB DWY

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	4	196			143	3				3		4
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	4	218			159	3				3		4
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	7	742	.009	<1	9.9	A	9.9
	2								
	3								A
		1	4	1410	.003	<1	7.6	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	EV	Jurisdiction/Date	POIPU 10/14/200
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK HOUR 2003	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		
Lane 2				LR
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	11	307			331	8				8		11
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	12	341			368	9				9		12
Flare storage (# of vehs)												0
Median storage (# of vehs)											0	

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	21	505	.042	<1	12.4	B	12.4
	2								
	3								B
		1	12	1176	.01	<1	8.1	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	BK	Jurisdiction/Date	POIPU 8/12/2003
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK 2003	Minor Street	KIAHUNA PLANTATION ROAD
Comment	EXISTING		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	44	189	24	5	113	29	3	1	4	23	1	26
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	49	210	27	6	126	32	3	1	4	26	1	29
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	8	586	.014	<1	11.2	B	11.2
	2								
	3								B
SB	1	LTR	56	632	.089	<1	11.2	B	11.2
	2								
	3								B
		1	49	1416	.035	<1	7.6	A	
		4	6	1325	.004	<1	7.7	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information		
Analyst	BK	Jurisdiction/Date	POIPU	8/12/2003
Agency or Company	ATA	Major Street	POIPU ROAD	
Analysis Period/Year	PM PEAK 2003	Minor Street	KIAHUNA PLANTATION ROAD	
Comment	EXISTING			

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	83	242	382	13	262	76	25	4	15	23	1	26
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	92	269	424	14	291	84	28	4	17	26	1	29
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	49	242	.202	1	23.6	C	23.6
	2								
	3								C
SB	1	LTR	56	297	.188	1	19.9	C	19.9
	2								
	3								C
		1	92	1177	.078	<1	8.3	A	
		4	14	897	.016	<1	9.1	A	

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2006 without Project

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2006	Minor Street	POIPU ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		235	235	170	80		105		105			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		261	261	189	89		117		117			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	117	655	.179	1	11.7	B	18.9
	2	L	105	267	.394	2	27	D	C
	3								
SB	1								
	2								
	3								
		1							
		4	189	1039	.182	1	9.2	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	POIPU ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		220	240	295	270		220		280			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		244	267	328	300		244		311			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	311	667	.466	2	15	B	265.4
	2	L	244	116	2.1	20	584.5	F	F
	3								
SB	1								
	2								
	3								
		1							
		4	328	1049	.312	1	10	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2006	Minor Street	MALUHIA ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	100	270			130	65				50		135
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	111	300			144	72				56		150
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	150	860	.175	1	10.1	B	11.8
	2	L	56	369	.152	1	16.5	C	
	3								B
		1	111	1347	.082	<1	7.9	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	MALUHIA ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	230	335			385	80				90		225
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	256	372			428	89				100		250
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	250	590	.424	2	15.5	C	40.4
	2	L	100	124	.808	5	102.5	F	E
	3								
		1	256	1044	.245	1	9.6	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	AM PEAK B2006	Minor Street	ALA KINO IKI
Comment	BASE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		140	5	145	180		5		135			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		156	6	161	200		6		150			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	150	888	.169	1	9.9	A	10.1
	2	L	6	369	.016	<1	14.9	B	
	3								B
EB	1								
	2								
	3								
		1							
		4	161	1412	.114	<1	7.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	ALA KINO IKI
Comment	BASE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		235	10	225	275		15		240			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		261	11	250	306		17		267			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	267	775	.344	2	12.1	B	12.8
	2	L	17	197	.086	<1	25	C	
	3								B
EB	1								
	2								
	3								
		1							
		4	250	1285	.195	1	8.5	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	TL
Agency or Company	ATA
Analysis Period/Year	AM PEAK B2006
Comment	BASE 2006

Site Information

Jurisdiction/Date	POIPU 7/20/2005
Major Street	KOLOA ROAD
Minor Street	WELIWELI ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		245	170	15	195		75		10			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		272	189	17	217		83		11			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	94	464	.203	1	14.7	B	14.7
	2								
	3								B
SB	1								
	2								
	3								
		1							
		4	17	1095	.015	<1	8.3	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	TL
Agency or Company	ATA
Analysis Period/Year	PM PEAK B2006
Comment	BASE 2006

Site Information

Jurisdiction/Date	POIPU 7/20/2005
Major Street	KOLOA ROAD
Minor Street	WELIWELI ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		315	145	25	325		130		30			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		350	161	28	361		144		33			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	177	354	.5	3	24.9	C	24.9 C
	2								
	3								
SB	1								
	2								
	3								
		1							
		4	28	1049	.026	<1	8.5	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	AM PEAK B2006	Minor Street	HAPA ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	NB			SB			WB			EB		
Lane 1 (curb)	LT			TR						R		
Lane 2										L		
Lane 3												
	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	65			200	5				10		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	72			222	6				11		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	11	812	.014	<1	9.5	A	9.9
	2	L	11	679	.016	<1	10.4	B	
	3								A
		1	6	1335	.004	<1	7.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	HAPA ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	165			110	15				10		5
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	183			122	17				11		6
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	6	916	.007	<1	9	A	10
	2	L	11	664	.017	<1	10.5	B	
	3								A
		1	6	1438	.004	<1	7.5	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	AM PEAK B2006	Minor Street	WELIWELI ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	55	135	5	5	160	5	5	10	10	5	25	180
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	61	150	6	6	178	6	6	11	11	6	28	200
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	LTR	28	500	.056	<1	12.6	B	12.6
	2								
	3								B
EB	1	LTR	234	766	.306	1	11.8	B	11.8
	2								
	3								B
		1	61	1386	.044	<1	7.7	A	
		4	6	1418	.004	<1	7.5	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	PM PEAK B2006	Minor Street	WELIWELI ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	NB			SB			WB			EB		
Lane 1 (curb)	TR			TR			LTR			LTR		
Lane 2	L			L								
Lane 3												
	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	150	240	10	10	200	5	10	25	10	5	15	100
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	167	267	11	11	222	6	11	28	11	6	17	111
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	LTR	50	273	.183	1	21.1	C	21.1
	2								
	3								C
EB	1	LTR	134	580	.231	1	13.1	B	13.1
	2								
	3								B
		1	167	1335	.125	<1	8.1	A	
		4	11	1279	.009	<1	7.8	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2006	Minor Street	EASTERN BYPASS
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	R	LTR	R
Lane 2	L	LT		LT
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	70	55	50	10	35	35	45	60	10	150	110	105
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	78	61	56	11	39	39	50	67	11	167	122	117
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	128	472	.271	1	15.4	C	15.4
	2								
	3								C
SB	1	R	117	1030	.114	<1	8.9	A	16.4
	2	LT	289	533	.542	3	19.5	C	
	3								C
		1	78	1514	.051	<1	7.5	A	
		4	11	1466	.008	<1	7.5	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	EASTERN BYPASS
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	R	LTR	R
Lane 2	L	LT		LT
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	125	105	65	25	120	125	60	110	35	80	65	140
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	139	117	72	28	133	139	67	122	39	89	72	156
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	228	279	.816	7	56.9	F	56.9
	2								
	3								F
SB	1	R	156	913	.171	1	9.8	A	26.3
	2	LT	161	249	.645	4	42.4	E	
	3								D
		1	139	1285	.108	<1	8.1	A	
		4	28	1379	.02	<1	7.7	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2006	Minor Street	KIPUKA STREET
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	20	130			160	10				20		25
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	22	144			178	11				22		28
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	50	731	.068	<1	10.3	B	10.3
	2								
	3								B
		1	22	1379	.016	<1	7.7	A	
		4							

HiCAP 2000 ™

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	KIPUKA STREET
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	30	280			290	25				25		20
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	33	311			322	28				28		22
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	50	481	.104	<1	13.3	B	13.3
	2								
	3								B
		1	33	1203	.028	<1	8.1	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: TL
Agency or Company: ATA
Analysis Period/Year: AM PEAK B2006
Comment: BASE 2006

Site Information

Jurisdiction/Date: POIPU 7/20/2005
Major Street: POIPU ROAD
Minor Street: HOOWILI ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		150	85	30	145		60		20			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		167	94	33	161		67		22			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	22	824	.027	<1	9.5	A	11.6
	2	L	67	557	.12	<1	12.4	B	
	3								B
SB	1								
	2								
	3								
		1							
		4	33	1297	.026	<1	7.8	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	HOOWILI ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		235	140	50	270		135		65			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		261	156	56	300		150		72			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	72	701	.103	<1	10.7	B	18.4
	2	L	150	359	.418	2	22	C	
	3								C
SB	1								
	2								
	3								
		1							
		4	56	1137	.049	<1	8.3	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK HOUR B2006	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	BASE YEAR 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	225			165	5				5		5
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	250			183	6				6		6
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	12	680	.018	<1	10.4	B	10.4
	2								
	3								B
		1	6	1379	.004	<1	7.6	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK HOUR B2006	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	BASE YEAR 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	15	350			375	10				10		15
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	17	389			417	11				11		17
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	28	462	.061	<1	13.3	B	13.3
	2								
	3								B
		1	17	1126	.015	<1	8.2	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2006	Minor Street	KIAHUNA PLANTATION ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	50	220	30	10	130	35	5	5	5	30	5	30
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	56	244	33	11	144	39	6	6	6	33	6	33
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	18	475	.038	<1	12.9	B	12.9
	2								
	3								B
SB	1	LTR	72	543	.133	<1	12.6	B	12.6
	2								
	3								B
		1	56	1386	.04	<1	7.7	A	
		4	11	1279	.009	<1	7.8	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/20/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2006	Minor Street	KIAHUNA PLANTATION ROAD
Comment	BASE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	95	280	20	15	300	85	30	5	20	60	10	105
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	106	311	22	17	333	94	33	6	22	67	11	117
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	61	229	.266	1	26.3	D	26.3
	2								
	3								D
SB	1	LTR	195	354	.551	3	27	D	27
	2								
	3								D
		1	106	1126	.094	<1	8.5	A	
		4	17	1220	.014	<1	8	A	

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	LHY		
Agency or Company	ATA		
Analysis Period/Year	AM PEAK	B2006	
Comment	BASE 2006 W/MITIGATIVE MEASURES		

Site Information

Jurisdiction/Date	POIPU	8/2/2005
EB-WB Street	POIPU ROAD	
NB-SB Street	ALA KINO IKI	

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		70		10	45			150
	Through	55			35	60			110
	Right-turn	50		35		10		105	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	117	78	39	50	128		117	289
Departure headway, h_d (s)	5.75	6.59	5.55	6.37	5.29		4.81	5.8
Degree of utilization, x	.186	.142	.06	.089	.188		.156	.466
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	3.45	4.29	3.25	4.07	2.99		2.51	3.5
Capacity (veh/h)	596	524	603	529	684		737	608
Delay (s) (Equation 17-55)	9.8	10.4	8.6	9.7	9.2		8.4	13.5
Level of service (Exhibit 17-22)	A	B	A	A	A		A	B
Delay (s), approach	10		9.2		9.2		12	
Level of service, approach	A		A		A		B	
Delay (s), intersection	10.8							
Level of service, intersection	B							

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information			Site Information		
Analyst	LHY		Jurisdiction/Date	POIPU	8/2/2005
Agency or Company	ATA		EB-WB Street	POIPU ROAD	
Analysis Period/Year	PM PEAK	B2006	NB-SB Street	ALA KINO IKI	
Comment	BASE 2006 W/MITIGATIVE MEASURES				

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		125		25	60			80
	Through	105			120	110			65
	Right-turn	65		125		35		140	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	189	139	139	161	228		156	161
Departure headway, h_d (s)	6.33	7.11	5.96	6.76	5.36		5.98	6.96
Degree of utilization, x	.332	.274	.23	.302	.339		.258	.312
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	4.03	4.81	3.66	4.46	3.06		3.68	4.66
Capacity (veh/h)	558	501	594	520	741		585	502
Delay (s) (Equation 17-55)	12.1	12.5	10.4	12.4	10.8		10.7	12.8
Level of service (Exhibit 17-22)	B	B	B	B	B		B	B
Delay (s), approach	12.3		11.5		10.8		11.8	
Level of service, approach	B		B		B		B	
Delay (s), intersection	11.6							
Level of service, intersection	B							

```
*******************************************************************************
*                                                                             *
*   4:8:05                 BASE 2006  POIPU/ALA KINOIKI                  19   *
*                                                                             *
*******************************************************************************
*                                                  *                          *
* E     (m)    4.57   4.57   4.57   4.57           * TIME PERIOD    min    90 *
* L'    (m)   10.00  10.00  10.00  10.00           * TIME SLICE     min    15 *
* V     (m)    3.66   3.66   3.66   3.66           * RESULTS PERIOD min  15 75 *
* RAD   (m)   30.00  30.00  30.00  30.00           * TIME COST     $/hr 15.00 *
* PHI   (d)   30.00  30.00  30.00  30.00           * FLOW PERIOD    min  15 75 *
* DIA   (m)   36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP        0      0      0      0           * FLOW PEAK am/op/pm    AM *
*                                                  *                          *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  105  110  150  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   35   35   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   10   60   45  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   50   55   70  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                                             *
* FLOW         veh      365     80    115    175          *                   *
* CAPACITY     veh     1181   1088   1167   1213          *                   *
* AVE DELAY   mins     0.07   0.06   0.06   0.06          * AVDEL s      3.8  *
* MAX DELAY   mins     0.09   0.07   0.07   0.07          * L  O  S        A  *
* AVE QUEUE    veh        0      0      0      0          * VEH HRS      0.8  *
* MAX QUEUE    veh        1      0      0      0          * COST  $     11.8  *
*                                                         *                   *
*                                                         *                   *
*******************************************************************************
```

```
*********************************************************************************
*                                                                               *
*   4:8:05                BASE 2006  POIPU/ALA KINOIKI                      20  *
*                                                                               *
*********************************************************************************
*                                                     *                         *
* E     (m)     4.57   4.57   4.57   4.57             * TIME PERIOD    min    90 *
* L'    (m)    10.00  10.00  10.00  10.00             * TIME SLICE     min    15 *
* V     (m)     3.66   3.66   3.66   3.66             * RESULTS PERIOD min 15 75 *
* RAD   (m)    30.00  30.00  30.00  30.00             * TIME COST     $/hr 15.00 *
* PHI   (d)    30.00  30.00  30.00  30.00             * FLOW PERIOD    min 15 75 *
* DIA   (m)    36.58  36.58  36.58  36.58             * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP         0      0      0      0             * FLOW PEAK am/op/pm    PM *
*                                                     *                         *
*********************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SB LEG   *1.05* 140   65   80  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05* 125  120   25  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*  35  110   60  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  65  105  125  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*********************************************************************************
*                                                          *                    *
* FLOW          veh     285    270    205    295           *                    *
* CAPACITY      veh    1111   1123   1149   1167           * AVDEL s        4.1 *
* AVE DELAY    mins    0.07   0.07   0.06   0.07           * L  O  S          A *
* MAX DELAY    mins    0.09   0.09   0.08   0.09           * VEH HRS        1.2 *
* AVE QUEUE     veh       0      0      0      0           * COST  $       17.8 *
* MAX QUEUE     veh       0      0      0      0           *                    *
*                                                          *                    *
*********************************************************************************
```

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2010 without Project

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	POIPU ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		365	50	285	180		30		245			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		406	56	317	200		33		272			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	272	620	.438	2	15.3	C	18.1
	2	L	33	132	.25	1	41.2	E	C
	3								
SB	1								
	2								
	3								
		1							
		4	317	1095	.289	1	9.6	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	POIPU ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		395	60	480	460		45		455			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		439	67	533	511		50		506			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	506	590	.858	10	37.3	E	1676 F
	2	L	306	30	10.182	38	4385.7	F	
	3								
SB	1								
	2								
	3								
		1							
		4	533	1054	.506	3	11.9	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	MALUHIA ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB			WB			NB			SB		
Lane 1 (curb)	T			TR						R		
Lane 2	L									L		
Lane 3												
	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	195	440			245	90				95		235
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	217	489			272	100				106		261
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	261	716	.364	2	12.9	B	18.4
	2	L	61	156	.39	2	42.1	E	
	3								C
		1	217	1181	.183	1	8.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	MALUHIA ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	370	555			620	170				155		370
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	411	617			689	189				172		411
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	411	392	1.048	14	91.8	F	1076.6
	2	L	172	22	7.85	22	3429.7	F	
	3								F
		1	411	765	.537	3	15	B	
		4							

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CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	ALA KINO IKI
Comment	BASE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		265	5	165	335		5		150			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		294	6	183	372		6		167			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	167	743	.225	1	11.2	B	11.6 B
	2	L	6	219	.027	<1	21.9	C	
	3								
EB	1								
	2								
	3								
		1							
		4	183	1255	.146	1	8.4	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	ALA KINO IKI
Comment	BASE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		470	15	260	490		20		275			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		522	17	289	544		22		306			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	306	553	.554	3	19.3	C	22.6 C
	2	L	22	78	.281	1	68.1	F	
	3								
EB	1								
	2								
	3								
		1							
		4	289	1024	.282	1	9.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		355	250	45	280		115		55			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		394	278	50	311		128		61			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	189	326	.58	3	30.2	D	30.2 D
	2								
	3								
SB	1								
	2								
	3								
		1							
		4	50	914	.055	<1	9.2	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		445	255	80	455		285		85			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		494	283	89	506		317		94			
Flare storage (# of vehs)									0			
Median storage (# of vehs)								0				

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	411	182	2.257	33	623.8	F	623.8 F
	2								
	3								
SB	1								
	2								
	3								
		1							
		4	89	834	.107	<1	9.8	A	

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CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	HAPA ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	120			265	5				20		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	133			294	6				22		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	11	740	.015	<1	9.9	A	11
	2	L	22	569	.039	<1	11.6	B	B
	3								
		1	6	1255	.004	<1	7.9	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	HAPA ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	NB			SB			WB			EB		
Lane 1 (curb)	LT			TR						R		
Lane 2										L		
Lane 3												
	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	250			185	20				10		5
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	278			206	22				11		6
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	6	821	.007	<1	9.4	A	11.1
	2	L	11	522	.021	<1	12	B	
	3								B
		1	6	1335	.004	<1	7.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information | **Site Information**

Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	AM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	110	150	5	5	190	5	5	15	10	5	30	250
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	122	167	6	6	211	6	6	17	11	6	33	278
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	LTR	34	358	.095	<1	16.1	C	16.1
	2								
	3								C
EB	1	LTR	317	707	.449	2	14.2	B	14.2
	2								
	3								B
		1	122	1347	.091	<1	7.9	A	
		4	6	1399	.004	<1	7.6	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	PM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	203	10	235	275	10	5	20	180	10	35	10
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	6	226	11	261	306	11	6	22	200	11	39	11
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	LTR	228	541	.421	2	16.4	C	16.4 C
	2								
	3								
WB	1	LTR	61	171	.356	1	37.2	E	37.2 E
	2								
	3								
		1	6	1238	.004	<1	7.9	A	
		4	261	1325	.197	1	8.4	A	

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	EB-WB Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2010	NB-SB Street	ALA KINO IKI
Comment	BASE 2010		

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		85		10	55			185
	Through	95			85	95			140
	Right-turn	55		50		10		140	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	167	94	56	106	178		156	361
Departure headway, h_d (s)	6.47	7.24	6.22	6.98	5.31		5.39	6.38
Degree of utilization, x	.3	.19	.096	.205	.262		.233	.64
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	4.17	4.94	3.92	4.68	3.01		3.09	4.08
Capacity (veh/h)	534	483	549	488	731		666	557
Delay (s) (Equation 17-55)	11.9	11.6	9.6	11.5	9.9		9.7	19.7
Level of service (Exhibit 17-22)	B	B	A	B	A		A	C
Delay (s), approach	11.8		10.8		9.9		16.7	
Level of service, approach	B		B		A		C	
Delay (s), intersection	13.6							
Level of service, intersection	B							

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	EB-WB Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2010	NB-SB Street	ALA KINO IKI
Comment	BASE 2010		

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		165		30	75			120
	Through	170			195	145			100
	Right-turn	75		170		35		180	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	272	183	189	250	283		200	244
Departure headway, h_d (s)	7.23	7.96	6.79	7.58	5.45		6.85	7.83
Degree of utilization, x	.547	.405	.357	.526	.429		.38	.532
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	4.93	5.66	4.49	5.28	3.15		4.55	5.53
Capacity (veh/h)	502	455	532	477	1125		522	458
Delay (s) (Equation 17-55)	18.3	16	13.2	18.4	12.2		13.7	19.1
Level of service (Exhibit 17-22)	C	C	B	C	B		B	C
Delay (s), approach	17.4		16.2		12.2		16.7	
Level of service, approach	C		C		B		C	
Delay (s), intersection	15.9							
Level of service, intersection	C							

```
*****************************************************************************
*                                                                           *
*   4:8:05               BASE 2010  POIPU/ALA KINOIKI                  21   *
*                                                                           *
*****************************************************************************
*                                                  *                        *
* E    (m)    4.57   4.57   4.57   4.57            * TIME PERIOD    min    90 *
* L'   (m)   10.00  10.00  10.00  10.00            * TIME SLICE     min    15 *
* V    (m)    3.66   3.66   3.66   3.66            * RESULTS PERIOD min 15 75 *
* RAD  (m)   30.00  30.00  30.00  30.00            * TIME COST     $/hr 15.00 *
* PHI  (d)   30.00  30.00  30.00  30.00            * FLOW PERIOD    min 15 75 *
* DIA  (m)   36.58  36.58  36.58  36.58            * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP       0      0      0      0            * FLOW PEAK am/op/pm    AM *
*                                                  *                        *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SB LEG   *1.05*  140  140  185  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   50   85   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   10   95   55  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   55   95   85  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*****************************************************************************
*                                                           *               *
* FLOW        veh     465    145    160    235              *               *
* CAPACITY    veh    1143   1041   1117   1187              * AVDEL s   4.4 *
* AVE DELAY  mins    0.09   0.07   0.06   0.06              * L  O  S     A *
* MAX DELAY  mins    0.12   0.09   0.08   0.08              * VEH HRS   1.2 *
* AVE QUEUE   veh       1      0      0      0              * COST $   18.6 *
* MAX QUEUE   veh       1      0      0      0              *               *
*                                                           *               *
*****************************************************************************
```

```
*****************************************************************************
*                                                                           *
*   4:8:05              BASE 2010  POIPU/ALA KINOIKI                   22  *
*                                                                           *
*****************************************************************************
*                                              *                            *
* E     (m)    4.57   4.57   4.57   4.57       * TIME PERIOD    min     90  *
* L'    (m)   10.00  10.00  10.00  10.00       * TIME SLICE     min     15  *
* V     (m)    3.66   3.66   3.66   3.66       * RESULTS PERIOD min  15 75  *
* RAD   (m)   30.00  30.00  30.00  30.00       * TIME COST     $/hr  15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00       * FLOW PERIOD    min  15 75  *
* DIA   (m)   36.58  36.58  36.58  36.58       * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP        0      0      0      0       * FLOW PEAK am/op/pm     PM  *
*                                              *                            *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  180  100  120  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  170  195   30  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   35  145   75  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   75  170  165  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                                                       *                   *
* FLOW         veh     400    395    255    410         *                   *
* CAPACITY     veh    1041   1056   1079   1135         * AVDEL s      5.1  *
* AVE DELAY   mins    0.09   0.09   0.07   0.08         * L  O  S        A  *
* MAX DELAY   mins    0.13   0.12   0.09   0.11         * VEH HRS      2.1  *
* AVE QUEUE    veh       1      1      0      1         * COST  $     31.0  *
* MAX QUEUE    veh       1      1      0      1         *                   *
*                                                       *                   *
*****************************************************************************
```

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: LHY
Agency or Company: ATA
Analysis Period/Year: AM PEAK B2010
Comment: BASE 2010

Site Information

Jurisdiction/Date: POIPU 8/4/2005
Major Street: POIPU ROAD
Minor Street: KIPUKA STREET

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	30	190			250	15				25		35
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	33	211			278	17				28		39
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	67	602	.111	<1	11.7	B	11.7
	2								
	3								B
		1	33	1261	.026	<1	7.9	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	KIPUKA STREET
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	40	390			420	25				25		25
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	44	433			467	28				28		28
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	56	356	.157	1	17	C	17 C
	2								
	3								
		1	44	1064	.042	<1	8.5	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	LHY
Agency or Company	ATA
Analysis Period/Year	AM PEAK B2010
Comment	BASE 2010

Site Information

Jurisdiction/Date	POIPU 8/4/2005
Major Street	POIPU ROAD
Minor Street	HOOWILI ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		215	125	30	235		85		25			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		239	139	33	261		94		28			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	28	729	.038	<1	10.1	B	14.5
	2	L	94	428	.22	1	15.8	C	
	3								B
SB	1								
	2								
	3								
		1							
		4	33	1175	.028	<1	8.2	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	HOOWILI ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		345	220	55	400		175		75			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		383	244	61	444		194		83			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	83	565	.147	1	12.5	B	54.5
	2	L	194	227	.853	7	72.5	F	
	3								F
SB	1								
	2								
	3								
		1							
		4	61	949	.064	<1	9.1	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	BASE YEAR 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	330			280	5				5		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	11	367			311	6				6		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	17	562	.03	<1	11.6	B	11.6
	2								
	3								B
		1	11	1238	.009	<1	7.9	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	BASE YEAR 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	15	535			540	10				10		15
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	17	594			600	11				11		17
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	28	305	.092	<1	18	C	18
	2								
	3								C
		1	17	963	.017	<1	8.8	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	KIAHUNA PLANTATON ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	65	325	40	10	245	40	5	5	5	30	5	45
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	72	361	44	11	272	44	6	6	6	33	6	50
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	18	317	.057	<1	17	C	17
	2								
	3								C
SB	1	LTR	89	410	.217	1	16.2	C	16.2
	2								
	3								C
		1	72	1238	.058	<1	8.1	A	
		4	11	1148	.01	<1	8.2	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	KIAHUNA PLANTATION ROAD
Comment	BASE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	125	455	25	20	455	95	35	5	20	65	10	140
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	139	506	28	22	506	106	39	6	22	72	11	156
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	67	88	.759	4	121.5	F	121.5
	2								
	3								F
SB	1	LTR	239	204	1.169	12	164.1	F	164.1
	2								
	3								F
		1	139	963	.144	1	9.4	A	
		4	22	1029	.022	<1	8.6	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010 W/ MITIGATIVE MEASURES		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		355	250	45	280		115		55			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		394	278	50	311		128		61			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	61	545	.112	<1	12.4	B	23.8
	2	L	128	274	.468	2	29.2	D	
	3								C
SB	1								
	2								
	3								
		1							
		4	50	914	.055	<1	9.2	A	

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CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010 W/MITIGATIVE MEASURES		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		445	255	80	455		285		85			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		494	283	89	506		317		94			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	94	476	.197	1	14.4	B	425.1
	2	L	317	154	2.059	25	546.8	F	F
	3								
SB	1								
	2								
	3								
		1							
		4	89	834	.107	<1	9.8	A	

```
*******************************************************************************
*                                                                             *
*   4:8:05         BASE 2010  ALA KINO/WELIWELI W/MIT MEAS                22  *
*                                                                             *
*******************************************************************************
*                                                   *                         *
* E     (m)    4.57   4.57   4.57   4.57            * TIME PERIOD    min    90  *
* L'    (m)   10.00  10.00  10.00  10.00            * TIME SLICE     min    15  *
* V     (m)    3.66   3.66   3.66   3.66            * RESULTS PERIOD min  15 75  *
* RAD   (m)   30.00  30.00  30.00  30.00            * TIME COST     $/hr  15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00            * FLOW PERIOD    min  15 75  *
* DIA   (m)   36.58  36.58  36.58  36.58            * FLOW TYPE  pcu/veh   VEH  *
* GRAD SEP       0      0      0      0            * FLOW PEAK am/op/pm    AM  *
*                                                   *                         *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*    5  190    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10   15    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*    5  150  110  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  250   30    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                              *              *
* FLOW         veh      200     30    265    285               *              *
* CAPACITY     veh     1196   1164   1266   1126               * AVDEL s  3.8 *
* AVE DELAY   mins     0.06   0.05   0.06   0.07               * L  O  S    A *
* MAX DELAY   mins     0.08   0.07   0.08   0.09               * VEH HRS  0.8 *
* AVE QUEUE    veh        0      0      0      0               * COST  $ 12.2 *
* MAX QUEUE    veh        0      0      0      0               *              *
*                                                              *              *
*******************************************************************************
```

```
*****************************************************************************
*                                                                           *
*   4:8:05         BASE 2010  ALA KINO/WELIWELI W/MIT MEAS             23   *
*                                                                           *
*****************************************************************************
*                                                *                          *
* E    (m)    4.57   4.57   4.57   4.57          * TIME PERIOD    min    90 *
* L'   (m)   10.00  10.00  10.00  10.00          * TIME SLICE     min    15 *
* V    (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD min  15 75 *
* RAD  (m)   30.00  30.00  30.00  30.00          * TIME COST     $/hr 15.00 *
* PHI  (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD    min  15 75 *
* DIA  (m)   36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP       0      0      0      0          * FLOW PEAK am/op/pm    PM *
*                                                *                          *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SB LEG   *1.05*    5  230   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10   35   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   10  275  235  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  180   20    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*****************************************************************************
*                                                           *               *
* FLOW         veh      245     55    520    205            *               *
* CAPACITY     veh     1129   1138   1248    977            * AVDEL s   4.5 *
* AVE DELAY   mins     0.07   0.05   0.08   0.08            * L  O  S     A *
* MAX DELAY   mins     0.09   0.07   0.11   0.10            * VEH HRS   1.3 *
* AVE QUEUE    veh        0      0      1      0            * COST $   19.3 *
* MAX QUEUE    veh        0      0      1      0            *               *
*                                                           *               *
*****************************************************************************
```

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	AM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010 - W/MITIGATIVE MEASURES		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	TR	TR	R	LTR
Lane 2	L	L	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	190	5	110	150	5	5	30	250	5	15	10
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	6	211	6	122	167	6	6	33	278	6	17	11
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	278	824	.338	1	11.6	B	12.2
	2	LT	39	351	.111	<1	16.5	C	
	3								B
WB	1	LTR	34	358	.095	<1	16.1	C	16.1
	2								
	3								C
		1	6	1399	.004	<1	7.6	A	
		4	122	1347	.091	<1	7.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	PM PEAK B2010	Minor Street	WELIWELI ROAD
Comment	BASE 2010 - W/MITIGATIVE MEASURES		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	TR	TR	R	LTR
Lane 2	L	L	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	230	5	235	275	10	5	20	180	10	35	10
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	11	256	6	261	306	11	6	22	200	11	39	11
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	200	778	.257	1	11.2	B	14
	2	LT	28	152	.185	1	34.1	D	
	3								B
WB	1	LTR	61	160	.38	2	40.6	E	40.6
	2								
	3								E
		1	11	1238	.009	<1	7.9	A	
		4	261	1297	.201	1	8.5	A	

Knudson Trust 08/09/05
Village at Poipu 19:02:52
AM Peak Hour of Traffic - Base Year 2010 w/Mitigative Measure

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	5	190	5	10	15	5	5	150	110	250	30	5
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1855	1207	0	1693	0	0	1853	1140	0	1638	0

Phasing Parameters

SEQUENCES	11	11					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	21.00	29.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust 08/09/05
Village at Poipu 19:02:39
AM Peak Hour of Traffic - Base Year 2010 w/Mitigative Measure

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.33 Vehicle Delay 13.8 Level of Service B+

```
      -------------------------
Sq 11 |  Phase 1  |  Phase 2  |
**/** -------------------------
      | + + +     |        ^  |
  .   | + + +     |       ++++|
 /|\  |<+ + +>    |      <++++|
  |   |   v       |   ^   ++++|
  |   |       ^   |****   v   |
North |    <* + +>|****>      |
  |   |      * + +|****       |
      |      * + +|   v       |
      -------------------------
      | G/C=0.350 | G/C=0.483 |
      | G=  21.0" | G=  29.0" |
      | Y+R= 5.0" | Y+R= 5.0" |
      | OFF= 0.0% | OFF=43.3% |
      -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								15.7	B	
RT+TH	12/1	0.170	0.350	577	649	217	0.334	15.7	B	134 ft
LT	12/1	0.000	0.350	351	422	6	0.014	12.8	B+	4 ft
NB Approach								15.5	B	
RT+TH	12/1	0.147	0.350	577	649	173	0.267	15.0	B+	106 ft
LT	12/1	0.178	0.350	329	399	122	0.306	16.2	*B	79 ft
WB Approach								8.3	A	
RT+TH+LT	12/1	0.062	0.483	772	818	34	0.042	8.3	A	16 ft
EB Approach								11.4	B+	
RT+TH+LT	12/1	0.248	0.483	744	791	317	0.401	11.4	*B+	169 ft

Knudson Trust 08/09/05
Village at Poipu 19:03:56
PM Peak Hour of Traffic - Base Year 2010 w/Mitigative Measure

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE		C		S
NODELOCATION		0		0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	5	230	10	10	35	10	10	275	235	180	20	5
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1856	1008	0	1708	0	0	1853	1109	0	1634	0

Phasing Parameters

SEQUENCES	11	11					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	30.00	20.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust 08/09/05
Village at Poipu 19:03:49
PM Peak Hour of Traffic - Base Year 2010 w/Mitigative Measure

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.36 Vehicle Delay 12.3 Level of Service B+

```
      -------------------------
Sq 11 |  Phase 1   |  Phase 2   |
**/** -------------------------
      | + + +      |        ^   |
  .   | + + +      |        ++++|
 /|\  |<+ + +>     |      <++++|
  |   |   v        |    ^   ++++|
  |   |       ^    |****    v   |
North |    <* + +>|****>       |
  |   |     * + + |****        |
      |     * + + |    v        |
      -------------------------
      | G/C=0.500 | G/C=0.333 |
      | G=  30.0" | G=  20.0" |
      | Y+R= 5.0" | Y+R= 5.0" |
      | OFF= 0.0% | OFF=58.3% |
      -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								9.4	A	
RT+TH	12/1	0.194	0.500	888	928	262	0.282	9.5	A	129 ft
LT	12/1	0.000	0.500	453	504	11	0.022	7.7	A	5 ft
NB Approach								11.2	B+	
RT+TH	12/1	0.222	0.500	887	927	317	0.342	10.1	B+	159 ft
LT	12/1	0.304	0.500	504	554	261	0.471	12.7	*B+	149 ft
WB Approach								14.2	B+	
RT+TH+LT	12/1	0.084	0.333	494	569	61	0.107	14.2	B+	38 ft
EB Approach								17.8	B	
RT+TH+LT	12/1	0.197	0.333	470	545	228	0.418	17.8	*B	149 ft

```
*******************************************************************************
*                                                                             *
*   4:8:05              BASE 2010 W/MIT MEAS POIPU/HOOWILI                 9  *
*                                                                             *
*******************************************************************************
*                                                  *                          *
* E     (m)     4.57   4.57   4.57                 * TIME PERIOD    min    90 *
* L'    (m)    10.00  10.00  10.00                 * TIME SLICE     min    15 *
* V     (m)     3.66   3.66   3.66                 * RESULTS PERIOD min 15 75 *
* RAD   (m)    30.00  30.00  30.00                 * TIME COST     $/hr 15.00 *
* PHI   (d)    30.00  30.00  30.00                 * FLOW PERIOD    min 15 75 *
* DIA   (m)    36.58  36.58  36.58                 * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP         0      0      0                 * FLOW PEAK am/op/pm    AM *
*                                                  *                          *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* WB LEG   *1.05* 235   30     0             *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*  25   85     0             *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05* 125  215     0             *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                              *              *
* FLOW         veh     265    110    340                       *              *
* CAPACITY     veh    1155   1263   1231                       * AVDEL s  3.8 *
* AVE DELAY   mins    0.07   0.05   0.07                       * L  O  S    A *
* MAX DELAY   mins    0.09   0.06   0.09                       * VEH HRS  0.8 *
* AVE QUEUE    veh       0      0      0                       * COST $  11.4 *
* MAX QUEUE    veh       0      0      0                       *              *
*                                                              *              *
*******************************************************************************
```

```
*****************************************************************************
*                                                                           *
*   4:8:05          BASE 2010 W/MIT MEAS POIPU/HOOWILI                 10   *
*                                                                           *
*****************************************************************************
*                                                  *                        *
* E     (m)     4.57   4.57   4.57                 * TIME PERIOD    min    90  *
* L'    (m)    10.00  10.00  10.00                 * TIME SLICE     min    15  *
* V     (m)     3.66   3.66   3.66                 * RESULTS PERIOD min  15 75 *
* RAD   (m)    30.00  30.00  30.00                 * TIME COST     $/hr  15.00 *
* PHI   (d)    30.00  30.00  30.00                 * FLOW PERIOD    min  15 75 *
* DIA   (m)    36.58  36.58  36.58                 * FLOW TYPE  pcu/veh   VEH  *
* GRAD SEP        0      0      0                  * FLOW PEAK am/op/pm   PM   *
*                                                  *                        *
*****************************************************************************
* LEG NAME  *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*           *    *                            *    *  *               *         *
* WB LEG    *1.05*  400   55    0             *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG    *1.05*   75  175    0             *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG    *1.05*  220  345    0             *1.00*50*0.75 1.125 0.75*15 45 75 *
*           *    *                            *    *  *               *         *
*           *    *                            *    *  *               *         *
*           *    *                            *    *  *               *         *
*           *    *                            *    *  *               *         *
*****************************************************************************
*                                                            *              *
* FLOW          veh     455    250    565                    *              *
* CAPACITY      veh    1079   1248   1178                    * AVDEL s   5.3 *
* AVE DELAY    mins    0.09   0.06   0.10                    * L  O  S     A *
* MAX DELAY    mins    0.13   0.08   0.13                    * VEH HRS   1.9 *
* AVE QUEUE     veh       1      0      1                    * COST  $  28.1 *
* MAX QUEUE     veh       1      0      1                    *              *
*                                                            *              *
*****************************************************************************
```

Knudsen Trust
Village at Poipu
AM Peak Hour of Traffic - Base Year 2010

08/09/05
16:49:56

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	0	0	0	0	235	30	25	0	85	125	215	0
WIDTHS	0.0	0.0	0.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	12.0	0.0
LANES	0	0	0	0	1	1	1	0	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	YES	YES	YES	NO	YES	YES	YES	NO
REQCLEARANCES	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	0	0	0	1863	950	1583	0	1770	0	1770	0

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	12.00	38.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudsen Trust — 08/09/05
Village at Poipu — 16:43:46
AM Peak Hour of Traffic - Base Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Hoowili Road
Degree of Saturation (v/c) 0.27 Vehicle Delay 7.4 Level of Service A

```
        -------------------------
Sq 11  |   Phase 1   |   Phase 2   |
**/**   -------------------------
       |             |             |
   .   |             |             |
  /|\  |             |       <++++|
   |   |             |        ++++|
   |   |             |         v   |
North  |     <*    +>|****>        |
   |   |      *    + |****         |
       |      *    + |   v         |
        -------------------------
       | G/C=0.200  | G/C=0.633  |
       | G=  12.0"  | G=  38.0"  |
       | Y+R= 5.0"  | Y+R= 5.0"  |
       | OFF= 0.0%  | OFF=28.3%  |
        -------------------------
       C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
NB Approach								20.4	C+	
RT	12/1	0.036	0.200	249	317	28	0.088	19.7	B	18 ft
LT	12/1	0.084	0.200	283	354	94	0.266	20.7	*C+	64 ft
WB Approach								4.7	A	
TH	12/1	0.179	0.633	1171	1180	261	0.221	4.8	A	90 ft
LT	12/1	0.000	0.633	572	602	33	0.055	4.2	A	11 ft
EB Approach								5.3	A	
RT+TH	12/1	0.253	0.633	1109	1121	378	0.337	5.3	*A	142 ft

Knudsen Trust 08/09/05
Village at Poipu 16:46:33
PM Peak Hour of Traffic - Base Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA			NONCBD	
SIMULATION PERIOD			15	
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	0	0	0	0	400	55	75	0	175	220	345	0
WIDTHS	0.0	0.0	0.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	12.0	0.0
LANES	0	0	0	0	1	1	1	0	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	YES	YES	YES	NO	YES	YES	YES	NO
REQCLEARANCES	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	0	0	0	1863	669	1583	0	1770	0	1765	0

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	13.00	36.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudsen Trust — 08/09/05
Village at Poipu — 16:46:20
PM Peak Hour of Traffic - Base Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Hoowili Road
Degree of Saturation (v/c) 0.47 Vehicle Delay 9.6 Level of Service A

```
        -------------------------
Sq 11  |   Phase 1   |   Phase 2   |
**/**   -------------------------
       |             |             |
  .    |             |             |
 /|\   |             |       <++++|
  |    |             |        ++++|
  |    |             |        v    |
North  |    <*    +>|****>         |
  |    |     *    + |****          |
       |     *    + |   v          |
        -------------------------
       | G/C=0.220  | G/C=0.610  |
       | G=  13.0"  | G=  36.0"  |
       | Y+R= 5.0"  | Y+R= 5.0"  |
       | OFF= 0.0%  | OFF=30.5%  |
        -------------------------
       C= 59 sec   G= 49.0 sec = 83.1%  Y=10.0 sec = 16.9%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	@E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
NB Approach								20.6	C+	
RT	12/1	0.084	0.220	282	349	83	0.238	19.3	B	54 ft
LT	12/1	0.148	0.220	321	390	194	0.497	21.1	*C+	136 ft
WB Approach								6.0	A	
TH	12/1	0.275	0.610	1124	1137	444	0.391	6.1	A	179 ft
LT	12/1	0.000	0.610	374	408	61	0.150	5.1	A	22 ft
EB Approach								7.8	A	
RT+TH	12/1	0.386	0.610	1061	1077	627	0.582	7.8	*A	297 ft

```
*****************************************************************************
*                                                                           *
*   8:8:05           BASE 2010  POIPU/KIAHUNA W/MIT MEAS               16  *
*                                                                           *
*****************************************************************************
*                                                  *                        *
* E     (m)     4.57   4.57   4.57   4.57          * TIME PERIOD    min    90  *
* L'    (m)    10.00  10.00  10.00  10.00          * TIME SLICE     min    15  *
* V     (m)     3.66   3.66   3.66   3.66          * RESULTS PERIOD min  15 75  *
* RAD   (m)    30.00  30.00  30.00  30.00          * TIME COST     $/hr  15.00  *
* PHI   (d)    30.00  30.00  30.00  30.00          * FLOW PERIOD    min  15 75  *
* DIA   (m)    36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh   VEH  *
* GRAD SEP         0      0      0      0          * FLOW PEAK am/op/pm    AM  *
*                                                  *                        *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*   45    5   30  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   40  245   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*    5    5    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   40  325   65  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                                                            *              *
* FLOW         veh       80     295     15     430           *              *
* CAPACITY     veh     1050    1222   1114    1268           * AVDEL s   4.0 *
* AVE DELAY   mins     0.06    0.06   0.05    0.07           * L  O  S     A *
* MAX DELAY   mins     0.08    0.08   0.07    0.09           * VEH HRS   0.9 *
* AVE QUEUE    veh        0       0      0       1           * COST  $  13.6 *
* MAX QUEUE    veh        0       0      0       1           *              *
*                                                            *              *
*****************************************************************************
```

```
********************************************************************************
*                                                                              *
*   8:8:05            BASE 2010  POIPU/KIAHUNA W/MIT MEAS                 17   *
*                                                                              *
********************************************************************************
*                                                   *                          *
* E     (m)     4.57   4.57   4.57   4.57           * TIME PERIOD    min     90  *
* L'    (m)    10.00  10.00  10.00  10.00           * TIME SLICE     min     15  *
* V     (m)     3.66   3.66   3.66   3.66           * RESULTS PERIOD min  15 75  *
* RAD   (m)    30.00  30.00  30.00  30.00           * TIME COST     $/hr  15.00  *
* PHI   (d)    30.00  30.00  30.00  30.00           * FLOW PERIOD    min  15 75  *
* DIA   (m)    36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP         0      0      0      0           * FLOW PEAK am/op/pm     PM  *
*                                                   *                          *
********************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  140   10   65  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   95  455   20  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   20    5   35  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   25  455  125  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
********************************************************************************
*                                                              *               *
* FLOW         veh      215    570     60    605               *               *
* CAPACITY     veh      922   1164    966   1245               * AVDEL s    5.6 *
* AVE DELAY   mins     0.08   0.10   0.06   0.09               * L  O  S      A *
* MAX DELAY   mins     0.11   0.14   0.08   0.13               * VEH HRS    2.2 *
* AVE QUEUE    veh        0      1      0      1               * COST  $   33.7 *
* MAX QUEUE    veh        0      1      0      1               *               *
*                                                              *               *
********************************************************************************
```

Knudsen Trust 08/09/05
Village at Poipu 16:12:16
AM Peak Hour of Traffic - Base Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA				NONCBD
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	45	5	30	40	245	10	5	5	5	40	325	65
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1536	0	0	1824	932	0	1632	0	0	1832	1059

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	10		PEDTIME	0.0	0
GREENTIMES	13.00	37.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	2	11					
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:12:10
AM Peak Hour of Traffic - Base Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.29 Vehicle Delay 7.3 Level of Service A

```
        -------------------------
Sq 11 |   Phase 1   |   Phase 2   |
**/** -------------------------
      | * * *       |         ^   |
   .  | * * *       |       ++++|
 /|\  |<* * *>      |      <++++|
  |   |   v         |    ^   ++++|
  |   |        ^    |++++    v   |
North |     <+ + +>|****>        |
  |   |       + + + |****        |
      |       + + + |    v       |
        -------------------------
      | G/C=0.217  | G/C=0.617  |
      | G=   13.0" | G=   37.0" |
      | Y+R= 5.0"  | Y+R= 5.0"  |
      | OFF= 0.0%  | OFF=30.0%  |
        -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	@E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								20.0	B	
RT+TH+LT	12/1	0.092	0.217	266	333	89	0.267	20.0	*B	60 ft
NB Approach								18.7	B	
RT+TH+LT	12/1	0.000	0.217	285	354	18	0.051	18.7	B	11 ft
WB Approach								5.4	A	
RT+TH	12/1	0.213	0.617	1111	1125	316	0.281	5.5	A	118 ft
LT	12/1	0.000	0.617	543	575	11	0.019	4.5	A	4 ft
EB Approach								5.7	A	
RT+TH	12/1	0.259	0.617	1117	1130	405	0.358	5.9	*A	160 ft
LT	12/1	0.074	0.617	623	653	72	0.110	4.8	A	25 ft

Knudsen Trust 08/09/05
Village at Poipu 16:11:26
PM Peak Hour of Traffic - Base Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	140	10	65	95	455	20	20	5	35	25	455	125
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1510	0	0	1814	615	0	1370	0	0	1848	506

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	120	120	10		PEDTIME	0.0	0
GREENTIMES	46.00	64.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	2	5					
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:11:18
PM Peak Hour of Traffic - Base Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.53 Vehicle Delay 21.3 Level of Service C+

```
        -------------------------
Sq 11  |   Phase 1   |   Phase 2   |
**/**   -------------------------
       | * * *       |          ^  |
   .   | * * *       |       ****|
 /|\   |<* * *>      |      <****|
  |    |    v        |    ^   ++++|
  |    |        ^    |++++    v   |
North  |     <+ + +>|++++>        |
  |    |      + + + |++++         |
       |      + + + |    v        |
        -------------------------
       | G/C=0.383 | G/C=0.533 |
       | G=  46.0" | G=  64.0" |
       | Y+R= 5.0" | Y+R= 5.0" |
       | OFF= 0.0% | OFF=42.5% |
        -------------------------
       C=120 sec   G=110.0 sec = 91.7%  Y=10.0 sec =  8.3%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								27.6	C	
RT+TH+LT	12/1	0.309	0.383	407	579	239	0.413	27.6	*C	268 ft
NB Approach								24.1	C+	
RT+TH+LT	12/1	0.258	0.383	364	525	67	0.128	24.1	C+	69 ft
WB Approach								20.8	C+	
RT+TH	12/1	0.429	0.533	860	968	612	0.632	21.1	*C+	629 ft
LT	12/1	0.255	0.533	260	328	22	0.067	13.6	B+	17 ft
EB Approach								19.1	B	
RT+TH	12/1	0.393	0.533	878	986	534	0.542	19.0	B	515 ft
LT	12/1	0.420	0.533	209	268	139	0.515	19.7	B	148 ft

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2015 without Project

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	LHY
Agency or Company	ATA
Analysis Period/Year	AM PEAK B2015
Comment	BASE 2015

Site Information

Jurisdiction/Date	POIPU 8/4/2005
Major Street	KOLOA ROAD
Minor Street	POIPU ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		435	55	370	220		35		335			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		483	61	411	244		39		372			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	372	559	.666	5	23.4	C	31.1
NB	2	L	39	71	.548	2	104.9	F	D
NB	3								
SB	1								
SB	2								
SB	3								
		1							
		4	411	1020	.403	2	10.9	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2015	Minor Street	POIPU ROAD
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		495	65	630	570		50		605			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		550	72	700	633		56		672			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	672	508	1.322	29	181.9	F	488.3 F
	2	L	56	7	7.981	9	4165	F	
	3								
SB	1								
	2								
	3								
		1							
		4	700	954	.734	7	18.4	C	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2015	Minor Street	MALUHIA ROAD
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	275	530			310	100				100		295
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	306	589			344	111				111		328
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	328	648	.506	3	16.1	C	87.1
	2	L	111	84	1.325	8	296.9	F	
	3								F
		1	306	1100	.278	1	9.5	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2015	Minor Street	MALUHIA ROAD
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	490	695			765	180				170		495
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	544	772			850	200				189		550
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	550	314	1.751	35	379.4	F	7014.5
	2	L	189	3	54.891	26	26323.3	F	
	3								F
		1	544	659	.826	9	31	D	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	AM PEAK B2015	Minor Street	ALA KINO IKI
Comment	BASE 2015		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		345	5	195	405		5		190			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		383	6	217	450		6		211			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	211	662	.319	1	13	B	13.4
	2	L	6	151	.04	<1	29.8	D	
	3								B
EB	1								
	2								
	3								
		1							
		4	217	1164	.186	1	8.8	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	PM PEAK B2015	Minor Street	ALA KINO IKI
Comment	BASE 2015		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		595	15	315	620		25		325			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		661	17	350	689		28		361			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	361	461	.784	7	35.7	E	50
	2	L	28	37	.748	3	233.2	F	
	3								E
EB	1								
	2								
	3								
		1							
		4	350	909	.385	2	11.4	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK B2015	Minor Street	WELIWELI ROAD
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		415	280	55	320		120		65			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		461	311	61	356		133		72			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	72	488	.147	1	13.6	B	33.5 D
	2	L	133	218	.609	4	44.2	E	
	3								
SB	1								
	2								
	3								
		1							
		4	61	838	.073	<1	9.6	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK B2015	Minor Street	WELIWELI ROAD
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		510	275	95	530		305		95			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		567	306	106	589		339		106			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft   Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	106	427	.249	1	16.2	C	759.8
	2	L	339	112	3.021	32	992.3	F	
	3								F
SB	1								
	2								
	3								
		1							
		4	106	769	.137	<1	10.4	B	

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CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	LHY
Agency or Company	ATA
Analysis Period/Year	AM PEAK B2015
Comment	BASE 2015

Site Information

Jurisdiction/Date	POIPU 8/4/2005
Major Street	WELIWELI ROAD
Minor Street	HAPA ROAD

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	140			305	10				20		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	156			339	11				22		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	11	696	.016	<1	10.3	B	11.6
	2	L	22	518	.042	<1	12.3	B	
	3								B
		1	6	1203	.005	<1	8	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	PM PEAK B2015	Minor Street	HAPA ROAD
Comment	BASE 2015		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	285			215	20				10		5
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	317			239	22				11		6
Flare storage (# of vehs)												0
Median storage (# of vehs)											0	

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	6	786	.008	<1	9.6	A	11.7
	2	L	11	474	.023	<1	12.8	B	B
	3								
		1	6	1297	.004	<1	7.8	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	LHY
Agency or Company	ATA
Analysis Period/Year	AM PEAK B2015
Comment	BASE 2015

Site Information

Jurisdiction/Date	POIPU 8/5/2005
Major Street	ALA KINO IKI
Minor Street	WELIWELI ROAD

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	TR	TR	R	LTR
Lane 2	L	L	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	225	5	130	195	5	5	35	290	5	15	10
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	11	250	6	144	217	6	6	39	322	6	17	11
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	322	783	.411	2	12.8	B	13.7
	2	LT	45	281	.16	1	20.2	C	
	3								B
WB	1	LTR	34	269	.127	<1	20.3	C	20.3
	2								
	3								C
		1	11	1341	.008	<1	7.7	A	
		4	144	1304	.111	<1	8.1	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	PM PEAK B2015	Minor Street	WELIWELI ROAD
Comment	BASE 2015		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	TR	TR	R	LTR
Lane 2	L	L	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	290	5	270	330	10	5	25	225	10	40	15
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	11	322	6	300	367	11	6	28	250	11	44	17
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	250	714	.35	2	12.7	B	17.8
	2	LT	34	104	.326	1	55.3	F	C
	3								
WB	1	LTR	72	112	.642	3	82.2	F	82.2
	2								F
	3								
		1	11	1175	.009	<1	8.1	A	
		4	300	1226	.245	1	8.9	A	

```
*************************************************************************************
*                                                                                   *
*   4:8:05                BASE 2015  ALA KINO/WELIWELI                        21   *
*                                                                                   *
*************************************************************************************
*                                                   *                               *
* E     (m)     4.57   4.57   4.57   4.57           * TIME PERIOD    min       90   *
* L'    (m)    10.00  10.00  10.00  10.00           * TIME SLICE     min       15   *
* V     (m)     3.66   3.66   3.66   3.66           * RESULTS PERIOD min    15 75   *
* RAD   (m)    30.00  30.00  30.00  30.00           * TIME COST     $/hr    15.00   *
* PHI   (d)    30.00  30.00  30.00  30.00           * FLOW PERIOD    min    15 75   *
* DIA   (m)    36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh      VEH   *
* GRAD SEP         0      0      0      0           * FLOW PEAK am/op/pm       AM   *
*                                                   *                               *
*************************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO    *FLOW TIME*
*          *    *                            *    *  *                *         *
* SB LEG   *1.05*    5  225   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10   15    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*    5  195  130  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  290   35    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *                *         *
*          *    *                            *    *  *                *         *
*          *    *                            *    *  *                *         *
*************************************************************************************
*                                                            *                      *
* FLOW         veh      240     30    330    330             *                      *
* CAPACITY     veh     1181   1140   1263   1088             * AVDEL s        4.1  *
* AVE DELAY   mins     0.06   0.05   0.06   0.08             * L  O  S          A  *
* MAX DELAY   mins     0.08   0.07   0.08   0.10             * VEH HRS        1.0  *
* AVE QUEUE    veh        0      0      0      0             * COST  $       15.7  *
* MAX QUEUE    veh        0      0      0      1             *                      *
*                                                            *                      *
*************************************************************************************
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*********************************************************************************
*                                                                               *
*   4:8:05                 BASE 2015  ALA KINO/WELIWELI                    20   *
*                                                                               *
*********************************************************************************
*                                                 *                             *
* E     (m)     4.57   4.57   4.57   4.57         * TIME PERIOD     min     90  *
* L'    (m)    10.00  10.00  10.00  10.00         * TIME SLICE      min     15  *
* V     (m)     3.66   3.66   3.66   3.66         * RESULTS PERIOD min  15 75   *
* RAD   (m)    30.00  30.00  30.00  30.00         * TIME COST     $/hr  15.00   *
* PHI   (d)    30.00  30.00  30.00  30.00         * FLOW PERIOD     min  15 75  *
* DIA   (m)    36.58  36.58  36.58  36.58         * FLOW TYPE  pcu/veh    VEH   *
* GRAD SEP         0      0      0      0         * FLOW PEAK am/op/pm     PM   *
*                                                 *                             *
*********************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SB LEG   *1.05*   5  290   10  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  15   40   10  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*  10  330  270  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05* 225   25    5  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*********************************************************************************
*                                                            *                  *
* FLOW         veh      305     65    610    255             *                  *
* CAPACITY     veh     1105   1103   1245    925             * AVDEL s     5.1  *
* AVE DELAY   mins     0.07   0.06   0.09   0.09             * L  O  S       A  *
* MAX DELAY   mins     0.10   0.07   0.13   0.12             * VEH HRS     1.8  *
* AVE QUEUE    veh        0      0      1      0             * COST  $    26.4  *
* MAX QUEUE    veh        0      0      1      0             *                  *
*                                                            *                  *
*********************************************************************************
```

Knudson Trust 08/09/05
Village at Poipu 19:15:54
AM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	5	225	10	10	15	5	5	195	130	290	35	5
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1856	1134	0	1684	0	0	1855	1053	0	1638	0

Phasing Parameters

SEQUENCES	11	11					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	22.00	28.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust 08/09/05
Village at Poipu 19:15:31
AM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.39 Vehicle Delay 14.5 Level of Service B+

```
      -------------------------
Sq 11 |  Phase 1   |  Phase 2  |
**/** -------------------------
      | + + +      |        ^  |
  .   | + + +      |       ++++|
 /|\  |<+ + +>     |     <++++|
  |   |   v        |    ^  ++++|
  |   |       ^    |****   v   |
North |    <* + +>|****>       |
  |   |      * + + |****       |
      |      * + + |    v      |
      -------------------------
      | G/C=0.367  | G/C=0.467 |
      | G=  22.0"  | G=  28.0" |
      | Y+R= 5.0"  | Y+R= 5.0" |
      | OFF= 0.0%  | OFF=45.0% |
      -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								15.4	B	
RT+TH	12/1	0.190	0.367	612	681	256	0.376	15.5	B	156 ft
LT	12/1	0.000	0.367	348	416	11	0.026	12.3	B+	7 ft
NB Approach								15.6	B	
RT+TH	12/1	0.173	0.367	611	680	223	0.328	15.0	B+	134 ft
LT	12/1	0.212	0.367	318	386	144	0.373	16.7	*B	94 ft
WB Approach								8.8	A	
RT+TH+LT	12/1	0.062	0.467	736	786	34	0.043	8.8	A	17 ft
EB Approach								13.2	B+	
RT+TH+LT	12/1	0.276	0.467	714	764	367	0.480	13.2	*B+	208 ft

Knudson Trust 08/09/05
Village at Poipu 19:17:22
pM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	5	290	10	15	40	10	10	330	270	225	25	5
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1858	913	0	1696	0	0	1855	998	0	1634	0

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	31.00	19.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust 08/09/05
Village at Poipu 19:17:11
pM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.44 Vehicle Delay 13.5 Level of Service B+

```
       -------------------------
Sq 11  |   Phase 1   |  Phase 2   |
**/**  -------------------------
       | + + +       |        ^   |
  .    | + + +       |        ++++|
 /|\   |<+ + +>      |      <++++|
  |    |   v         |    ^   ++++|
  |    |       ^     |****    v   |
North  |    <* + +>|****>         |
  |    |      * + +  |****        |
       |      * + +  |    v       |
       -------------------------
       | G/C=0.517 | G/C=0.317 |
       | G=  31.0" | G=  19.0" |
       | Y+R= 5.0" | Y+R= 5.0" |
       | OFF= 0.0% | OFF=60.0% |
       -------------------------
       C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								9.4	A	
RT+TH	12/1	0.227	0.517	923	960	328	0.342	9.5	A	160 ft
LT	12/1	0.000	0.517	422	472	11	0.023	7.2	A	5 ft
NB Approach								12.1	B+	
RT+TH	12/1	0.252	0.517	921	958	378	0.395	10.0	B+	189 ft
LT	12/1	0.368	0.517	467	516	300	0.581	14.7	*B+	182 ft
WB Approach								15.1	B	
RT+TH+LT	12/1	0.093	0.317	459	537	72	0.134	15.1	B	46 ft
EB Approach								21.1	C+	
RT+TH+LT	12/1	0.229	0.317	439	517	284	0.549	21.1	*C+	196 ft

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information			Site Information		
Analyst	LHY		Jurisdiction/Date	POIPU	8/4/2005
Agency or Company	ATA		EB-WB Street	POIPU ROAD	
Analysis Period/Year	AM PEAK	B2015	NB-SB Street	ALA KINO IKI	
Comment	BASE 2015				

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		130		10	65			210
	Through	140			130	105			155
	Right-turn	65		55		15		175	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	228	144	61	156	206		194	406
Departure headway, h_d (s)	6.99	7.72	6.81	7.56	5.34		5.98	6.98
Degree of utilization, x	.442	.31	.116	.327	.305		.323	.786
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	4.69	5.42	4.51	5.26	3.04		3.68	4.68
Capacity (veh/h)	506	462	514	458	941		602	513
Delay (s) (Equation 17-55)	15.1	13.9	10.4	13.9	10.4		11.5	30.7
Level of service (Exhibit 17-22)	C	B	B	B	B		B	D
Delay (s), approach	14.6		12.9		10.4		24.5	
Level of service, approach	B		B		B		C	
Delay (s), intersection	18							
Level of service, intersection	C							

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	EB-WB Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2015	NB-SB Street	ALA KINO IKI
Comment	BASE 2015		

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		210		30	85			135
	Through	235			295	165			110
	Right-turn	85		190		40		250	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	356	233	211	361	322		278	272
Departure headway, h_d (s)	7.89	8.59	7.4	8.17	5.39		7.52	8.51
Degree of utilization, x	.779	.557	.434	.82	.483		.58	.644
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	5.59	6.29	5.1	5.87	3.09		5.22	6.21
Capacity (veh/h)	454	415	478	438	1125		471	417
Delay (s) (Equation 17-55)	33.2	21.6	15.7	38.6	13		20.1	25.3
Level of service (Exhibit 17-22)	D	C	C	E	B		C	D
Delay (s), approach	28.6		30.1		13		22.7	
Level of service, approach	D		D		B		C	
Delay (s), intersection	25							
Level of service, intersection	C							

```
********************************************************************************
*                                                                              *
*   4:8:05           BASE 2015 W/MIT MEAS  POIPU/Ala Kino                 15   *
*                                                                              *
********************************************************************************
*                                                 *                            *
* E     (m)    4.57   4.57   4.57   4.57          * TIME PERIOD    min     90  *
* L'    (m)   10.00  10.00  10.00  10.00          * TIME SLICE     min     15  *
* V     (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD min  15 75  *
* RAD   (m)   30.00  30.00  30.00  30.00          * TIME COST     $/hr  15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD    min  15 75  *
* DIA   (m)   36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP        0      0      0      0          * FLOW PEAK am/op/pm     AM  *
*                                                 *                            *
********************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  175  155  210  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   55  130   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   15  105   65  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   65  140  130  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
********************************************************************************
*                                                            *                 *
* FLOW         veh      540    195    185    335             *                 *
* CAPACITY     veh     1085    992   1076   1175             * AVDEL s     5.2 *
* AVE DELAY   mins     0.11   0.07   0.07   0.07             * L  O  S       A *
* MAX DELAY   mins     0.15   0.10   0.09   0.09             * VEH HRS     1.8 *
* AVE QUEUE    veh        1      0      0      0             * COST  $    27.3 *
* MAX QUEUE    veh        1      0      0      0             *                 *
*                                                            *                 *
********************************************************************************
```

```
*****************************************************************************
*                                                                           *
*   4:8:05           BASE 2015 W/MIT MEAS  POIPU/Ala Kino             16   *
*                                                                           *
*****************************************************************************
*                                                  *                        *
* E    (m)    4.57   4.57   4.57   4.57            * TIME PERIOD    min    90  *
* L'   (m)   10.00  10.00  10.00  10.00            * TIME SLICE     min    15  *
* V    (m)    3.66   3.66   3.66   3.66            * RESULTS PERIOD min  15 75  *
* RAD  (m)   30.00  30.00  30.00  30.00            * TIME COST     $/hr  15.00  *
* PHI  (d)   30.00  30.00  30.00  30.00            * FLOW PERIOD    min  15 75  *
* DIA  (m)   36.58  36.58  36.58  36.58            * FLOW TYPE  pcu/veh   VEH  *
* GRAD SEP       0      0      0      0            * FLOW PEAK am/op/pm    PM  *
*                                                  *                        *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  250  110  135  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  190  295   30  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   40  165   85  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   85  235  210  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                                                           *               *
* FLOW        veh      495    515    290    530             *               *
* CAPACITY    veh      972   1015   1012   1117             * AVDEL s    6.6 *
* AVE DELAY  mins     0.13   0.12   0.08   0.10             * L  O  S      A *
* MAX DELAY  mins     0.18   0.17   0.11   0.14             * VEH HRS    3.4 *
* AVE QUEUE   veh        1      1      0      1             * COST  $   50.4 *
* MAX QUEUE   veh        1      1      0      1             *               *
*                                                           *               *
*****************************************************************************
```

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2015	Minor Street	KIPUKA STREET
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	30	285			330	15				30		35
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	33	317			367	17				33		39
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	72	482	.149	1	13.8	B	13.8
	2								
	3								B
		1	33	1170	.028	<1	8.2	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2015	Minor Street	KIPUKA STREET
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	45	515			600	30				30		30
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	50	572			667	33				33		33
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	66	230	.287	1	26.9	D	26.9
	2								
	3								D
		1	50	892	.056	<1	9.3	A	
		4							

```
*******************************************************************************
*                                                                             *
*   4:8:05                  BASE 2015  POIPU/HOOWILI                     7   *
*                                                                             *
*******************************************************************************
*                                                   *                         *
* E     (m)    4.57   4.57   4.57                   * TIME PERIOD    min    90  *
* L'    (m)   10.00  10.00  10.00                   * TIME SLICE     min    15  *
* V     (m)    3.66   3.66   3.66                   * RESULTS PERIOD min  15 75 *
* RAD   (m)   30.00  30.00  30.00                   * TIME COST     $/hr  15.00 *
* PHI   (d)   30.00  30.00  30.00                   * FLOW PERIOD    min  15 75 *
* DIA   (m)   36.58  36.58  36.58                   * FLOW TYPE  pcu/veh    VEH *
* GRAD SEP        0      0      0                   * FLOW PEAK am/op/pm     AM *
*                                                   *                         *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO    *FLOW TIME*
*          *    *                            *    *  *                *         *
* WB LEG   *1.05*  315   35     0            *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   25   95     0            *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  155  315     0            *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *                *         *
*          *    *                            *    *  *                *         *
*          *    *                            *    *  *                *         *
*          *    *                            *    *  *                *         *
*******************************************************************************
*                                                            *                *
* FLOW         veh      350    120    470                    *                *
* CAPACITY     veh     1097   1260   1225                    * AVDEL s    4.5 *
* AVE DELAY   mins     0.08   0.05   0.08                    * L  O  S      A *
* MAX DELAY   mins     0.11   0.07   0.10                    * VEH HRS    1.2 *
* AVE QUEUE    veh        0      0      1                    * COST  $   17.6 *
* MAX QUEUE    veh        1      0      1                    *                *
*                                                            *                *
*******************************************************************************
```

```
********************************************************************************
*                                                                              *
*   4:8:05                  BASE 2015  POIPU/HOOWILI                       8   *
*                                                                              *
********************************************************************************
*                                                  *                           *
* E    (m)    4.57   4.57   4.57                   * TIME PERIOD    min     90 *
* L'   (m)   10.00  10.00  10.00                   * TIME SLICE     min     15 *
* V    (m)    3.66   3.66   3.66                   * RESULTS PERIOD min  15 75 *
* RAD  (m)   30.00  30.00  30.00                   * TIME COST     $/hr  15.00 *
* PHI  (d)   30.00  30.00  30.00                   * FLOW PERIOD    min  15 75 *
* DIA  (m)   36.58  36.58  36.58                   * FLOW TYPE  pcu/veh    VEH *
* GRAD SEP       0      0      0                   * FLOW PEAK am/op/pm     PM *
*                                                  *                           *
********************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* WB LEG   *1.05*  575   65    0             *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   85  200    0             *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  270  460    0             *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
********************************************************************************
*                                                            *                 *
* FLOW         veh      640    285    730                    *                 *
* CAPACITY     veh     1012   1242   1164                    * AVDEL s     8.2 *
* AVE DELAY   mins     0.17   0.06   0.14                    * L  O  S       A *
* MAX DELAY   mins     0.25   0.08   0.21                    * VEH HRS     3.8 *
* AVE QUEUE    veh        2      0      2                    * COST  $    56.4 *
* MAX QUEUE    veh        2      0      2                    *                 *
*                                                            *                 *
********************************************************************************
```

Knudsen Trust 08/09/05
Village at Poipu 16:55:24
AM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	0	0	0	0	315	35	25	0	95	155	315	0
WIDTHS	0.0	0.0	0.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	12.0	0.0
LANES	0	0	0	0	1	1	1	0	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	2	2	2
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	0	0	0	1863	648	1583	0	1770	0	1780	0

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	10		PEDTIME	0.0	0
GREENTIMES	13.00	37.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:55:15
AM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Hoowili Road
Degree of Saturation (v/c) 0.37 Vehicle Delay 9.3 Level of Service A

```
      -------------------------
Sq 11 |   Phase 1   |  Phase 2  |
**/** -------------------------
      |             |           |
  .   |             |           |
 /|\  |             |      <++++|
  |   |             |       ++++|
  |   |             |       v   |
North |    <*    +>|****>       |
  |   |      *    + |****       |
      |      *    + |   v       |
      -------------------------
      | G/C=0.217 | G/C=0.617 |
      | G=  13.0" | G=  37.0" |
      | Y+R= 5.0" | Y+R= 5.0" |
      | OFF= 0.0% | OFF=30.0% |
      -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
NB Approach								20.9	C+	
RT	12/1	0.059	0.217	253	343	28	0.082	19.2	B	20 ft
LT	12/1	0.112	0.217	290	383	106	0.277	21.4	*C+	77 ft
WB Approach								5.5	A	
TH	12/1	0.227	0.617	1136	1149	350	0.305	5.6	A	133 ft
LT	12/1	0.000	0.617	365	399	39	0.098	4.8	A	14 ft
EB Approach								9.2	A	
RT+TH	12/1	0.333	0.617	1061	1098	522	0.475	9.2	*A	293 ft

Knudsen Trust 08/09/05
Village at Poipu 16:57:05
PM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA				NONCBD
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	0	0	0	0	575	65	85	0	200	270	460	0
WIDTHS	0.0	0.0	0.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	12.0	0.0
LANES	0	0	0	0	1	1	1	0	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	2	2	2
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	0	0	0	1863	389	1583	0	1770	0	1770	0

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	10		PEDTIME	0.0	0
GREENTIMES	13.00	37.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:56:52
PM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Hoowili Road
Degree of Saturation (v/c) 0.62 Vehicle Delay 13.5 Level of Service B+

```
       -------------------------
Sq 11 |   Phase 1   |  Phase 2  |
**/** -------------------------
      |             |           |
  .   |             |           |
 /|\  |             |      <++++|
  |   |             |       ++++|
  |   |             |       v   |
North |    <*    +>|****>       |
  |   |     *    + |****        |
      |     *    + |   v        |
       -------------------------
      | G/C=0.217  | G/C=0.617  |
      | G=  13.0"  | G=  37.0"  |
      | Y+R= 5.0"  | Y+R= 5.0"  |
      | OFF= 0.0%  | OFF=30.0%  |
       -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
NB Approach								25.6	C+	
RT	12/1	0.115	0.217	253	343	94	0.274	21.5	C+	69 ft
LT	12/1	0.180	0.217	290	383	222	0.580	27.3	*C+	171 ft
WB Approach								7.2	A	
TH	12/1	0.374	0.617	1136	1149	639	0.556	7.3	A	296 ft
LT	12/1	0.074	0.617	207	240	72	0.300	6.1	A	30 ft
EB Approach								14.4	B+	
RT+TH	12/1	0.489	0.617	1054	1091	811	0.743	14.4	*B+	531 ft

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK B2015	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	460			370	5				5		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	11	511			411	6				6		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	17	444	.038	<1	13.4	B	13.4
	2								
	3								B
		1	11	1137	.01	<1	8.2	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK B2015	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	BASE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	20	700			740	15				15		20
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	22	778			822	17				17		22
Flare storage (# of vehs)												0
Median storage (# of vehs)											0	

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	39	175	.222	1	31.3	D	31.3
	2								
	3								D
		1	22	791	.028	<1	9.7	A	
		4							

```
********************************************************************************
*                                                                              *
*   4:8:05              BASE 2015  POIPU/KIAHUNA AM PEAK                  13  *
*                                                                              *
********************************************************************************
*                                                  *                           *
* E     (m)    4.57   4.57   4.57   4.57           * TIME PERIOD    min     90  *
* L'    (m)   10.00  10.00  10.00  10.00           * TIME SLICE     min     15  *
* V     (m)    3.66   3.66   3.66   3.66           * RESULTS PERIOD min  15 75  *
* RAD   (m)   30.00  30.00  30.00  30.00           * TIME COST     $/hr  15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00           * FLOW PERIOD    min  15 75  *
* DIA   (m)   36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP        0      0      0      0           * FLOW PEAK am/op/pm     AM  *
*                                                  *                           *
********************************************************************************
* LEG NAME  *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*           *    *                             *    *  *              *         *
* SB LEG    *1.05*  125    5    85  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG    *1.05*   65  305    10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG    *1.05*   10    5     5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG    *1.05*   45  400   110  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*           *    *                             *    *  *              *         *
*           *    *                             *    *  *              *         *
*           *    *                             *    *  *              *         *
********************************************************************************
*                                                             *                *
* FLOW         veh      215    380     20    555              *                *
* CAPACITY     veh      980   1164   1047   1268              * AVDEL s   4.7 *
* AVE DELAY   mins     0.08   0.08   0.06   0.08              * L  O  S     A *
* MAX DELAY   mins     0.10   0.10   0.07   0.11              * VEH HRS   1.5 *
* AVE QUEUE    veh        0      0      0      1              * COST  $  23.0 *
* MAX QUEUE    veh        0      1      0      1              *                *
*                                                             *                *
********************************************************************************
```

```
*******************************************************************************
*                                                                             *
*   4:8:05              BASE 2015  POIPU/KIAHUNA PM PEAK                   8  *
*                                                                             *
*******************************************************************************
*                                                 *                           *
* E    (m)    4.57   4.57   4.57   4.57           * TIME PERIOD    min     90  *
* L'   (m)   10.00  10.00  10.00  10.00           * TIME SLICE     min     15  *
* V    (m)    3.66   3.66   3.66   3.66           * RESULTS PERIOD min  15 75  *
* RAD  (m)   30.00  30.00  30.00  30.00           * TIME COST     $/hr  15.00  *
* PHI  (d)   30.00  30.00  30.00  30.00           * FLOW PERIOD    min  15 75  *
* DIA  (m)   36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP       0      0      0      0           * FLOW PEAK am/op/pm     PM  *
*                                                 *                           *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  225   10  110  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  165  585   20  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   25   10   40  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   30  575  225  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                           *                 *
* FLOW         veh     345    770     75    830             *                 *
* CAPACITY     veh     791   1079    864   1239             * AVDEL s     9.9 *
* AVE DELAY   mins    0.14   0.21   0.07   0.15             * L  O  S       A *
* MAX DELAY   mins    0.20   0.33   0.10   0.22             * VEH HRS     5.6 *
* AVE QUEUE    veh       1      3      0      2             * COST  $    83.6 *
* MAX QUEUE    veh       1      4      0      3             *                 *
*                                                           *                 *
*******************************************************************************
```

Knudsen Trust 08/09/05
Village at Poipu 16:31:26
AM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA			NONCBD	
SIMULATION PERIOD			15	
LEVELOFSERVICE		C	S	
NODELOCATION		0	0	
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	125	5	85	65	305	10	10	5	5	45	400	110
WIDTHS	0.0	12.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	1	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1478	0	1583	1863	1770	0	1592	0	0	1834	1770

Phasing Parameters

SEQUENCES	16	16					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	60		PEDTIME	0.0	0
GREENTIMES	15.00	8.00	0.00	22.00			
YELLOWTIMES	5.00	5.00	0.00	5.00			
CRITICALS	2	12	0	11			
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:31:19
AM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.58 Vehicle Delay 19.9 Level of Service B

```
       -------------------------------------------------
Sq 16 |  Phase 1   |  Phase 2   |  Phase 3   |  Phase 4   |
**/** -------------------------------------------------
      | * * *      |            |            |        ^   |
  .   | * * *      |            |            |       ++++|
 /|\  |<* * *>     |            |            |      <++++|
  |   |   v        |   ^    ++++|   ^        |            |
  |   |       ^    |****    v   |++++        |            |
North |    <+ + +>|            |++++>       |****>       |
  |   |     + + + |            |++++        |****        |
      |     + + + |            |   v        |   v        |
       -------------------------------------------------
      | G/C=0.250  | G/C=0.133  | G/C=0.000  | G/C=0.367  |
      | G=  15.0"  | G=   8.0"  | G=   0.0"  | G=  22.0"  |
      | Y+R= 5.0"  | Y+R= 5.0"  | Y+R= 0.0"  | Y+R= 5.0"  |
      | OFF= 0.0%  | OFF=33.3%  | OFF=55.0%  | OFF=55.0%  |
       -------------------------------------------------
      C= 60 sec   G= 45.0 sec = 75.0%  Y=15.0 sec = 25.0%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								24.0	C+	
RT+TH+LT	12/1	0.207	0.250	304	370	239	0.646	24.0	*C+	179 ft
NB Approach								17.2	B	
RT+TH+LT	12/1	0.000	0.250	331	398	23	0.058	17.2	B	14 ft
WB Approach								15.1	B	
RT	12/1	0.099	0.367	512	581	72	0.124	13.0	B+	43 ft
TH	12/1	0.221	0.367	625	683	339	0.496	15.3	B	208 ft
LT	12/1	0.018	0.133	170	233	11	0.047	22.8	C+	8 ft
EB Approach								21.7	C+	
RT+TH	12/1	0.306	0.367	615	673	494	0.734	20.6	*C+	348 ft
LT	12/1	0.103	0.133	170	233	122	0.517	26.2	*C+	95 ft

Knudsen Trust 08/09/05
Village at Poipu 16:30:18
PM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	225	10	110	165	585	20	25	10	40	30	575	225
WIDTHS	0.0	12.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	1	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1473	0	1583	1863	1770	0	1225	0	0	1849	1770

Phasing Parameters

SEQUENCES	16	16					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	90	90	60		PEDTIME	0.0	0
GREENTIMES	26.00	5.00	5.00	33.00			
YELLOWTIMES	5.00	5.00	5.00	5.00			
CRITICALS	2	6	12	5			
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:30:11
PM Peak Hour of Traffic - Base Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.78 Vehicle Delay 38.3 Level of Service D+

```
      -------------------------------------------------
Sq 16 |  Phase 1  |  Phase 2  |  Phase 3  |  Phase 4  |
**/** -------------------------------------------------
      | * * *     |           |           |        ^  |
  .   | * * *     |           |           |       ++++|
 /|\  |<* * *>    |           |           |      <****|
  |   |   v       |   ^   ****|   ^       |           |
  |   |       ^   |++++   v   |****       |           |
North |    <+ + +>|           |++++>      |++++>      |
  |   |     + + + |           |++++       |++++       |
      |     + + + |           |   v       |   v       |
      -------------------------------------------------
      | G/C=0.292 | G/C=0.056 | G/C=0.056 | G/C=0.371 |
      | G=  26.0" | G=   5.0" | G=   5.0" | G=  33.0" |
      | Y+R= 5.0" | Y+R= 5.0" | Y+R= 5.0" | Y+R= 5.0" |
      | OFF= 0.0% | OFF=34.8% | OFF=46.1% | OFF=57.3% |
      -------------------------------------------------
      C= 89 sec   G= 69.0 sec = 77.5%  Y=20.0 sec = 22.5%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								50.2	D	
RT+TH+LT	12/1	0.332	0.292	318	430	383	0.891	50.2	*D	471 ft
NB Approach								24.3	C+	
RT+TH+LT	12/1	0.161	0.292	257	358	83	0.232	24.3	C+	75 ft
WB Approach								42.1	D+	
RT	12/1	0.228	0.371	461	587	183	0.312	21.3	C+	158 ft
TH	12/1	0.402	0.371	583	691	650	0.941	48.0	*D	787 ft
LT	12/1	0.121	0.056	1	81	22	0.222	41.3	*D+	26 ft
EB Approach								31.1	C	
RT+TH	12/1	0.415	0.483	817	893	672	0.753	22.3	C+	615 ft
LT	12/1	0.221	0.169	151	289	250	0.839	54.6	*D	313 ft

APPENDIX C
LEVEL OF SERVICE CALCULATIONS

- Year 2006 Traffic Operations with Project-Generated Traffic

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	POIPU ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		235	240	170	80		115		105			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		261	267	189	89		128		117			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	117	652	.179	1	11.7	B	21.6
	2	L	128	265	.482	2	30.6	D	
	3								C
SB	1								
	2								
	3								
		1							
		4	189	1034	.183	1	9.3	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK F2006	Minor Street	POIPU ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		220	250	295	270		225		280			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		244	278	328	300		250		311			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	311	662	.47	3	15.2	C	284.4
	2	L	250	115	2.178	21	619.2	F	
	3								F
SB	1								
	2								
	3								
		1							
		4	328	1039	.315	1	10.1	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	MALUHIA ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	100	270			130	65				50		135
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	111	300			144	72				56		150
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	150	860	.175	1	10.1	B	11.8
	2	L	56	369	.152	1	16.5	C	B
	3								
		1	111	1347	.082	<1	7.9	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK F2006	Minor Street	MALUHIA ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	230	335			385	80				90		225
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	256	372			428	89				100		250
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	250	590	.424	2	15.5	C	40.4
	2	L	100	124	.808	5	102.5	F	E
	3								
		1	256	1044	.245	1	9.6	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	ALA KINO IKI
Comment	FUTURE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		140	5	150	180		5		145			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		156	6	167	200		6		161			
Flare storage (# of vehs)									0			
Median storage (# of vehs)								0				

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	161	888	.181	1	10	A	10.1
	2	L	6	362	.017	<1	15.1	C	
	3								B
EB	1								
	2								
	3								
		1							
		4	167	1412	.118	<1	7.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	PM PEAK F2006	Minor Street	ALA KINO IKI
Comment	FUTURE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		235	10	235	275		15		250			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		261	11	261	306		17		278			
Flare storage (# of vehs)									0			
Median storage (# of vehs)								0				

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	278	775	.359	2	12.2	B	13
	2	L	17	189	.09	<1	25.9	D	
	3								B
EB	1								
	2								
	3								
		1							
		4	261	1285	.203	1	8.5	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	WELIWELI ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		245	175	20	200		75		15			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		272	194	22	222		83		17			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	100	459	.218	1	15	B	15
	2								
	3								B
SB	1								
	2								
	3								
		1							
		4	22	1090	.02	<1	8.4	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information			Site Information	
Analyst	TL		Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA		Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK	F2006	Minor Street	WELIWELI ROAD
Comment	FUTURE 2006			

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	LR	
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		315	150	30	330		130		35			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		350	167	33	367		144		39			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____ ft   Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LR	183	349	.525	3	26.2	D	26.2
	2								
	3								D
SB	1								
	2								
	3								
		1							
		4	33	1044	.032	<1	8.6	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	HAPA ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	70			205	5				10		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	78			228	6				11		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	11	806	.014	<1	9.5	A	10
	2	L	11	669	.016	<1	10.5	B	
	3								A
		1	6	1328	.004	<1	7.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	PM PEAK F2006	Minor Street	HAPA ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	170			115	15				10		5
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	189			128	17				11		6
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	6	910	.007	<1	9	A	10
	2	L	11	655	.017	<1	10.6	B	
	3								A
		1	6	1432	.004	<1	7.5	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	AM PEAK F2006	Minor Street	WELIWELI ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	60	145	5	5	165	5	5	10	10	5	25	185
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	67	161	6	6	183	6	6	11	11	6	28	206
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	LTR	28	479	.058	<1	13	B	13
	2								
	3								B
EB	1	LTR	240	756	.317	1	12	B	12
	2								
	3								B
		1	67	1379	.048	<1	7.7	A	
		4	6	1405	.004	<1	7.6	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	PM PEAK F2006	Minor Street	WELIWELI ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	155	250	10	10	210	5	10	25	10	5	15	105
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	172	278	11	11	233	6	11	28	11	6	17	117
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	LTR	50	258	.194	1	22.3	C	22.3
	2								
	3								C
EB	1	LTR	140	570	.246	1	13.4	B	13.4
	2								
	3								B
		1	172	1322	.13	<1	8.1	A	
		4	11	1267	.009	<1	7.9	A	

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information			Site Information		
Analyst	LHY		Jurisdiction/Date	POIPU	7/27/2005
Agency or Company	ATA		EB-WB Street	POIPU ROAD	
Analysis Period/Year	AM PEAK	F2006	NB-SB Street	ALA KINO IKI	
Comment	FUTURE 2006				

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		85		10	45			150
	Through	55			35	60			110
	Right-turn	50		35		10		115	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	117	94	39	50	128		128	289
Departure headway, h_d (s)	5.78	6.62	5.61	6.43	5.26		4.87	5.86
Degree of utilization, x	.187	.174	.061	.089	.187		.173	.47
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	3.48	4.32	3.31	4.13	2.96		2.57	3.56
Capacity (veh/h)	595	523	597	524	692		728	602
Delay (s) (Equation 17-55)	9.8	10.7	8.7	9.8	9.2		8.6	13.6
Level of service (Exhibit 17-22)	A	B	A	A	A		A	B
Delay (s), approach	10.2		9.3		9.2		12.1	
Level of service, approach	B		A		A		B	
Delay (s), intersection	10.9							
Level of service, intersection	B							

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/2/2005
Agency or Company	ATA	EB-WB Street	POIPU ROAD
Analysis Period/Year	PM PEAK F2006	NB-SB Street	ALA KINO IKI
Comment	FUTURE 2006		

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		135		25	60			80
	Through	105			120	110			65
	Right-turn	65		125		35		155	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	189	150	139	161	228		172	161
Departure headway, h_d (s)	6.37	7.15	6.02	6.82	5.35		6.02	7
Degree of utilization, x	.334	.298	.232	.305	.338		.288	.313
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	4.07	4.85	3.72	4.52	3.05		3.72	4.7
Capacity (veh/h)	556	498	587	515	752		582	501
Delay (s) (Equation 17-55)	12.2	12.9	10.5	12.5	10.8		11.1	12.9
Level of service (Exhibit 17-22)	B	B	B	B	B		B	B
Delay (s), approach	12.5		11.6		10.8		12	
Level of service, approach	B		B		B		B	
Delay (s), intersection	11.8							
Level of service, intersection	B							

```
********************************************************************************
*                                                                              *
*   4:8:05               FUT 2006  POIPU/ALA KINOIKI                       23  *
*                                                                              *
********************************************************************************
*                                                  *                           *
* E     (m)    4.57   4.57   4.57   4.57           * TIME PERIOD    min     90  *
* L'    (m)   10.00  10.00  10.00  10.00           * TIME SLICE     min     15  *
* V     (m)    3.66   3.66   3.66   3.66           * RESULTS PERIOD min  15 75  *
* RAD   (m)   30.00  30.00  30.00  30.00           * TIME COST     $/hr  15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00           * FLOW PERIOD    min  15 75  *
* DIA   (m)   36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP        0      0      0      0           * FLOW PEAK am/op/pm     AM  *
*                                                  *                           *
********************************************************************************
* LEG NAME  *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*           *    *                            *    *  *               *         *
* SB LEG    *1.05*  115  110  150  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG    *1.05*   35   35   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG    *1.05*   10   60   45  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG    *1.05*   50   55   85  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*           *    *                            *    *  *               *         *
*           *    *                            *    *  *               *         *
*           *    *                            *    *  *               *         *
********************************************************************************
*                                                             *                *
* FLOW         veh     375     80    115    190               *                *
* CAPACITY     veh    1172   1079   1167   1213               * AVDEL s    3.9 *
* AVE DELAY   mins    0.07   0.06   0.06   0.06               * L  O  S      A *
* MAX DELAY   mins    0.10   0.08   0.07   0.07               * VEH HRS    0.8 *
* AVE QUEUE    veh       0      0      0      0               * COST  $   12.4 *
* MAX QUEUE    veh       1      0      0      0               *                *
*                                                             *                *
********************************************************************************
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*******************************************************************************
*                                                                             *
*   4:8:05                FUT 2006  POIPU/ALA KINOIKI                    24   *
*                                                                             *
*******************************************************************************
*                                                   *                         *
* E    (m)    4.57   4.57   4.57   4.57             * TIME PERIOD    min   90 *
* L'   (m)   10.00  10.00  10.00  10.00             * TIME SLICE     min   15 *
* V    (m)    3.66   3.66   3.66   3.66             * RESULTS PERIOD min 15 75 *
* RAD  (m)   30.00  30.00  30.00  30.00             * TIME COST    $/hr 15.00 *
* PHI  (d)   30.00  30.00  30.00  30.00             * FLOW PERIOD    min 15 75 *
* DIA  (m)   36.58  36.58  36.58  36.58             * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP       0      0      0      0             * FLOW PEAK am/op/pm    PM *
*                                                   *                         *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  155   65   80  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  125  120   25  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   35  110   60  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   65  105  135  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                              *              *
* FLOW        veh     300    270    205    305                 *              *
* CAPACITY    veh    1105   1117   1149   1167                 * AVDEL s  4.1 *
* AVE DELAY  mins    0.07   0.07   0.06   0.07                 * L  O  S    A *
* MAX DELAY  mins    0.10   0.09   0.08   0.09                 * VEH HRS  1.2 *
* AVE QUEUE   veh       0      0      0      0                 * COST $  18.5 *
* MAX QUEUE   veh       0      0      0      0                 *              *
*                                                              *              *
*******************************************************************************
```

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	KIPUKA STREET
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	20	145			170	10				20		25
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	22	161			189	11				22		28
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	50	712	.07	<1	10.4	B	10.4
	2								
	3								B
		1	22	1366	.016	<1	7.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK F2006	Minor Street	KIPUKA STREET
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	30	290			305	25				25		20
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	33	322			339	28				28		22
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	50	466	.107	<1	13.7	B	13.7
	2								
	3								B
		1	33	1186	.028	<1	8.1	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	HOOWILI ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		165	85	30	155		60		20			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		183	94	33	172		67		22			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	22	806	.027	<1	9.6	A	11.9 B
	2	L	67	536	.125	<1	12.7	B	
	3								
SB	1								
	2								
	3								
		1							
		4	33	1279	.026	<1	7.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK F2006	Minor Street	HOOWILI ROAD
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		245	140	50	285		135		65			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		272	156	56	317		150		72			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	72	691	.104	<1	10.8	B	19.2
	2	L	150	346	.434	2	23.2	C	
	3								C
SB	1								
	2								
	3								
		1							
		4	56	1126	.049	<1	8.4	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK HOUR F2006	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	235			170	10				10		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	11	261			189	11				11		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	22	659	.033	<1	10.7	B	10.7
	2								
	3								B
		1	11	1366	.008	<1	7.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK HOUR F2006	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	20	355			385	20				15		20
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	22	394			428	22				17		22
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	39	431	.09	<1	14.2	B	14.2
	2								
	3								B
		1	22	1105	.02	<1	8.3	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK F2006	Minor Street	KIAHUNA PLANTATION DR
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	TR	LTR	LTR
Lane 2	L	L		
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	55	225	30	10	135	40	5	5	5	40	5	40
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	61	250	33	11	150	44	6	6	6	44	6	44
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	18	454	.04	<1	13.3	B	13.3
	2								
	3								B
SB	1	LTR	94	529	.178	1	13.3	B	13.3
	2								
	3								B
		1	61	1373	.045	<1	7.7	A	
		4	11	1273	.009	<1	7.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	TL	Jurisdiction/Date	POIPU 7/27/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK F2006	Minor Street	KIAHUNA PLANTATION DR
Comment	FUTURE 2006		

Input Data

Lane Configuration	EB			WB			NB			SB		
Lane 1 (curb)	TR			TR			LTR			LTR		
Lane 2	L			L								
Lane 3												
	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	105	285	20	15	305	95	30	5	20	65	10	110
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	117	317	22	17	339	106	33	6	22	72	11	122
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	LTR	61	211	.289	1	28.8	D	28.8
	2								
	3								D
SB	1	LTR	205	333	.615	4	31.6	D	31.6
	2								
	3								D
		1	117	1110	.105	<1	8.6	A	
		4	17	1215	.014	<1	8	A	

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2010 Traffic Operations with Project-Generated Traffic

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK 2005	Minor Street	POIPU ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		365	55	285	180		35		245			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		406	61	317	200		39		272			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	272	618	.44	2	15.3	C	18.9
	2	L	39	131	.298	1	43.7	E	C
	3								
SB	1								
	2								
	3								
		1							
		4	317	1090	.291	1	9.7	A	

HiCAP 2000 ™

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK 2005	Minor Street	POIPU ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		395	65	480	460		50		455			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		439	72	533	511		56		506			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	506	588	.861	10	37.8	E	103.7
	2	L	56	30	1.88	7	700	F	
	3								F
SB	1								
	2								
	3								
		1							
		4	533	1049	.508	3	11.9	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK 2005	Minor Street	MALUHIA ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	195	440			245	90				95		235
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	217	489			272	100				106		261
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	261	716	.364	2	12.9	B	28.4
	2	L	106	156	.679	4	66.5	F	
	3								D
		1	217	1181	.183	1	8.7	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK 2005	Minor Street	MALUHIA ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	370	555			620	170				155		370
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	411	617			689	189				172		411
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	411	392	1.048	14	91.8	F	1076.6
	2	L	172	22	7.85	22	3429.7	F	
	3								F
		1	411	765	.537	3	15	B	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	AM PEAK 2005	Minor Street	ALA KINO IKI
Comment	FUTURE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		265	5	180	335		5		185			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		294	6	200	372		6		206			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	206	743	.277	1	11.7	B	12
	2	L	6	206	.029	<1	23	C	
	3								B
EB	1								
	2								
	3								
		1							
		4	200	1255	.159	1	8.4	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	PM PEAK 2005	Minor Street	ALA KINO IKI
Comment	FUTURE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		470	15	295	490		20		300			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		522	17	328	544		22		333			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____________ ft Movement 5 ____________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	333	553	.603	4	20.9	C	24.8
	2	L	22	66	.332	1	84.2	F	
	3								C
EB	1								
	2								
	3								
		1							
		4	328	1024	.32	1	10.2	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK F2010	Minor Street	WELIWELI ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		355	255	55	285		115		70			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		394	283	61	317		128		78			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	78	543	.144	<1	12.7	B	24.5
	2	L	128	259	.494	3	31.7	D	
	3								C
SB	1								
	2								
	3								
		1							
		4	61	909	.067	<1	9.2	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK F2010	Minor Street	WELIWELI ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		445	265	95	460		285		95			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		494	294	106	511		317		106			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	106	473	.224	1	14.8	B	478.3
	2	L	317	141	2.245	26	633.3	F	F
	3								
SB	1								
	2								
	3								
		1							
		4	106	826	.128	<1	10	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	AM PEAK 2005	Minor Street	HAPA ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	140			275	5				20		10
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	156			306	6				22		11
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	11	729	.015	<1	10	A	11.3
	2	L	22	544	.04	<1	11.9	B	
	3								B
		1	6	1244	.004	<1	7.9	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	PM PEAK 2005	Minor Street	HAPA ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	265			205	20				10		5
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	6	294			228	22				11		6
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	6	798	.008	<1	9.5	A	11.4
	2	L	11	496	.022	<1	12.4	B	
	3								B
		1	6	1310	.004	<1	7.8	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	AM PEAK 2005	Minor Street	WELIWELI ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	TR	TR	R	LTR
Lane 2	L	L	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	5	205	5	130	185	5	5	30	260	5	15	10
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	6	228	6	144	206	6	6	33	289	6	17	11
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	289	806	.358	2	11.9	B	12.8
	2	LT	39	300	.13	<1	18.8	C	
	3								B
WB	1	LTR	34	303	.112	<1	18.4	C	18.4
	2								
	3								C
		1	6	1353	.004	<1	7.7	A	
		4	144	1328	.109	<1	8	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	PM PEAK 2005	Minor Street	WELIWELI ROAD
Comment	FUTURE 2010		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	TR	TR	R	LTR
Lane 2	L	L	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	265	5	250	300	10	5	20	200	10	35	10
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	11	294	6	278	333	11	6	22	222	11	39	11
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft   Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	222	740	.3	1	11.9	B	15.2
	2	LT	28	127	.221	1	41.2	E	
	3								C
WB	1	LTR	61	132	.463	2	54	F	54
	2								
	3								F
		1	11	1209	.009	<1	8	A	
		4	278	1255	.221	1	8.7	A	

```
*******************************************************************************
*                                                                             *
*   4:8:05                FUT 2010  ALA KINO/WELIWELI                    24   *
*                                                                             *
*******************************************************************************
*                                                 *                           *
* E    (m)     4.57   4.57   4.57   4.57          * TIME PERIOD    min      90  *
* L'   (m)    10.00  10.00  10.00  10.00          * TIME SLICE     min      15  *
* V    (m)     3.66   3.66   3.66   3.66          * RESULTS PERIOD min   15 75  *
* RAD  (m)    30.00  30.00  30.00  30.00          * TIME COST     $/hr   15.00  *
* PHI  (d)    30.00  30.00  30.00  30.00          * FLOW PERIOD    min   15 75  *
* DIA  (m)    36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh     VEH  *
* GRAD SEP        0      0      0      0          * FLOW PEAK am/op/pm      AM  *
*                                                 *                           *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO    *FLOW TIME*
*          *    *                            *    *  *                *         *
* SB LEG   *1.05*    5  205    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10   15    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*    5  185  130  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  260   30    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *                *         *
*          *    *                            *    *  *                *         *
*          *    *                            *    *  *                *         *
*******************************************************************************
*                                                           *                 *
* FLOW         veh      215     30    320    295            *                 *
* CAPACITY     veh     1184   1155   1266   1094            * AVDEL s     3.9 *
* AVE DELAY   mins     0.06   0.05   0.06   0.07            * L  O  S       A *
* MAX DELAY   mins     0.08   0.07   0.08   0.10            * VEH HRS     0.9 *
* AVE QUEUE    veh        0      0      0      0            * COST  $    14.0 *
* MAX QUEUE    veh        0      0      0      0            *                 *
*                                                           *                 *
*******************************************************************************
```

```
*******************************************************************************
*                                                                             *
*   4:8:05                 FUT 2010  ALA KINO/WELIWELI                   25  *
*                                                                             *
*******************************************************************************
*                                                *                            *
* E     (m)     4.57   4.57   4.57   4.57        * TIME PERIOD    min     90  *
* L'    (m)    10.00  10.00  10.00  10.00        * TIME SLICE     min     15  *
* V     (m)     3.66   3.66   3.66   3.66        * RESULTS PERIOD min  15 75  *
* RAD   (m)    30.00  30.00  30.00  30.00        * TIME COST     $/hr  15.00  *
* PHI   (d)    30.00  30.00  30.00  30.00        * FLOW PERIOD    min  15 75  *
* DIA   (m)    36.58  36.58  36.58  36.58        * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP         0      0      0      0        * FLOW PEAK am/op/pm     PM  *
*                                                *                            *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*    5  265   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10   35   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   10  300  250  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  200   20    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                           *                 *
* FLOW         veh      280     55    560    225            *                 *
* CAPACITY     veh     1120   1117   1248    954            * AVDEL s     4.8 *
* AVE DELAY   mins     0.07   0.06   0.09   0.08            * L  O  S       A *
* MAX DELAY   mins     0.09   0.07   0.12   0.11            * VEH HRS     1.5 *
* AVE QUEUE    veh        0      0      1      0            * COST  $    22.2 *
* MAX QUEUE    veh        0      0      1      0            *                 *
*                                                           *                 *
*******************************************************************************
```

Knudson Trust 08/10/05
Village at Poipu 10:17:25
AM Peak Hour of Traffic - Future Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	5	205	5	10	15	5	5	185	130	260	30	5
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1856	1161	0	1690	0	0	1855	1106	0	1637	0

Phasing Parameters

SEQUENCES	11	11					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	22.00	28.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust 08/10/05
Village at Poipu 10:17:17
AM Peak Hour of Traffic - Future Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.35 Vehicle Delay 14.1 Level of Service B+

```
       -------------------------
Sq 11 |  Phase 1   |  Phase 2  |
**/** -------------------------
      | + + +      |         ^ |
  .   | + + +      |      ++++|
 /|\  |<+ + +>     |     <++++|
  |   |   v        |    ^  ++++|
  |   |        ^   |****   v   |
North |     <* + +>|****>      |
  |   |      * + + |****       |
      |      * + + |   v       |
       -------------------------
      | G/C=0.367  | G/C=0.467 |
      | G=  22.0"  | G=  28.0" |
      | Y+R= 5.0"  | Y+R= 5.0" |
      | OFF= 0.0%  | OFF=45.0% |
       -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								15.1	B	
RT+TH	12/1	0.179	0.367	611	680	234	0.344	15.2	B	142 ft
LT	12/1	0.000	0.367	358	426	6	0.014	12.2	B+	4 ft
NB Approach								15.4	B	
RT+TH	12/1	0.167	0.367	611	680	212	0.312	14.8	B+	127 ft
LT	12/1	0.204	0.367	338	406	144	0.355	16.2	*B	93 ft
WB Approach								8.8	A	
RT+TH+LT	12/1	0.062	0.467	739	789	34	0.043	8.8	A	17 ft
EB Approach								12.4	B+	
RT+TH+LT	12/1	0.254	0.467	714	764	328	0.429	12.4	*B+	181 ft

Knudson Trust
Village at Poipu
PM Peak Hour of Traffic - Future Year 2010

08/10/05
10:18:21

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	5	265	10	10	35	10	10	300	250	200	20	5
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1857	971	0	1700	0	0	1854	1047	0	1631	0

Phasing Parameters

SEQUENCES	11	11					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	31.00	19.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust
Village at Poipu
PM Peak Hour of Traffic - Future Year 2010

08/10/05
10:18:13

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.39 Vehicle Delay 12.6 Level of Service B+

```
        -------------------------
Sq 11 |  Phase 1   |  Phase 2   |
**/** -------------------------
      | + + +      |        ^   |
  .   | + + +      |       ++++|
 /|\  |<+ + +>     |      <++++|
  |   |   v        |    ^  ++++|
  |   |       ^    |****   v    |
North |    <* + +>|****>        |
  |   |      * + + |****        |
      |      * + + |    v       |
        -------------------------
      | G/C=0.517  | G/C=0.317  |
      | G=  31.0"  | G=  19.0"  |
      | Y+R= 5.0"  | Y+R= 5.0"  |
      | OFF= 0.0%  | OFF=60.0%  |
        -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								9.1	A	
RT+TH	12/1	0.213	0.517	923	960	300	0.313	9.2	A	145 ft
LT	12/1	0.000	0.517	453	502	11	0.022	7.2	A	5 ft
NB Approach								11.2	B+	
RT+TH	12/1	0.235	0.517	921	958	344	0.359	9.7	A	169 ft
LT	12/1	0.334	0.517	493	541	278	0.514	13.0	*B+	160 ft
WB Approach								15.0	B+	
RT+TH+LT	12/1	0.084	0.317	460	538	61	0.113	15.0	B+	39 ft
EB Approach								19.8	B	
RT+TH+LT	12/1	0.210	0.317	439	517	250	0.484	19.8	*B	169 ft

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information			Site Information		
Analyst	LHY		Jurisdiction/Date	POIPU	8/4/2005
Agency or Company	ATA		EB-WB Street	POIPU ROAD	
Analysis Period/Year	AM PEAK	F2010	NB-SB Street	ALA KINO IKI	
Comment	FUTURE 2010				

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		135		10	55			185
	Through	105			90	95			140
	Right-turn	55		50		10		165	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	178	150	56	111	178		183	361
Departure headway, h_d (s)	6.58	7.33	6.42	7.18	5.28		5.61	6.59
Degree of utilization, x	.325	.305	.099	.222	.261		.286	.662
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	4.28	5.03	4.12	4.88	2.98		3.31	4.29
Capacity (veh/h)	534	481	535	477	821		639	539
Delay (s) (Equation 17-55)	12.4	13.2	9.8	11.9	9.8		10.5	21.2
Level of service (Exhibit 17-22)	B	B	A	B	A		B	C
Delay (s), approach	12.8		11.2		9.8		17.6	
Level of service, approach	B		B		A		C	
Delay (s), intersection	14.3							
Level of service, intersection	B							

CHAPTER 17 - AWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information			Site Information		
Analyst	LHY		Jurisdiction/Date	POIPU	8/4/2005
Agency or Company	ATA		EB-WB Street	POIPU ROAD	
Analysis Period/Year	PM PEAK	F2010	NB-SB Street	ALA KINO IKI	
Comment	FUTURE 2010				

Input Data

		EB		WB		NB		SB	
		Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Lane code (Lane 1 is curb lane)		TR	L	R	LT	LTR		R	LT
Volume (veh/h)	Left-turn		205		30	75			120
	Through	175			205	145			100
	Right-turn	75		170		35		235	
Peak-hour factor		.9	.9	.9	.9	.9		.9	.9
% Heavy vehicles		3	3	3	3	3		3	3

Outputs

	EB		WB		NB		SB	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Total lane flow rate (veh/h)	278	228	189	261	283		261	244
Departure headway, h_d (s)	7.39	8.12	7.01	7.79	5.41		6.99	7.97
Degree of utilization, x	.57	.514	.368	.565	.426		.507	.541
Move-up time, m (s)	2.3	2.3	2.3	2.3	2.3		2.3	2.3
Service time, t_s (s)	5.09	5.82	4.71	5.49	3.11		4.69	5.67
Capacity (veh/h)	487	443	510	461	1125		511	449
Delay (s) (Equation 17-55)	19.5	19.1	13.7	20.2	12.1		16.6	19.7
Level of service (Exhibit 17-22)	C	C	B	C	B		C	C
Delay (s), approach	19.3		17.5		12.1		18.1	
Level of service, approach	C		C		B		C	
Delay (s), intersection	17.3							
Level of service, intersection	C							

```
*****************************************************************************
*                                                                           *
*   4:8:05                FUT 2010  POIPU/ALA KINOIKI                  25   *
*                                                                           *
*****************************************************************************
*                                                 *                         *
* E     (m)     4.57   4.57   4.57   4.57         * TIME PERIOD    min   90  *
* L'    (m)    10.00  10.00  10.00  10.00         * TIME SLICE     min   15  *
* V     (m)     3.66   3.66   3.66   3.66         * RESULTS PERIOD min 15 75 *
* RAD   (m)    30.00  30.00  30.00  30.00         * TIME COST     $/hr 15.00 *
* PHI   (d)    30.00  30.00  30.00  30.00         * FLOW PERIOD    min 15 75 *
* DIA   (m)    36.58  36.58  36.58  36.58         * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP         0      0      0      0         * FLOW PEAK am/op/pm    AM *
*                                                 *                         *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05* 165  140  185  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  50   90   10  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*  10   95   55  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  55  105  135  0           *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                                                           *               *
* FLOW        veh     490    150    160    295              *               *
* CAPACITY    veh    1108   1012   1114   1187              * AVDEL s   4.7 *
* AVE DELAY  mins    0.10   0.07   0.06   0.09              * L O S       A *
* MAX DELAY  mins    0.13   0.09   0.08   0.09              * VEH HRS   1.4 *
* AVE QUEUE   veh       1      0      0      0              * COST $   21.6 *
* MAX QUEUE   veh       1      0      0      0              *               *
*                                                           *               *
*****************************************************************************
```

```
*******************************************************************************
*                                                                             *
*   4:8:05                FUT 2010  POIPU/ALA KINOIKI                     26  *
*                                                                             *
*******************************************************************************
*                                                      *                      *
* E     (m)     4.57   4.57   4.57   4.57             * TIME PERIOD    min    90 *
* L'    (m)    10.00  10.00  10.00  10.00             * TIME SLICE     min    15 *
* V     (m)     3.66   3.66   3.66   3.66             * RESULTS PERIOD min 15 75 *
* RAD   (m)    30.00  30.00  30.00  30.00             * TIME COST     $/hr 15.00 *
* PHI   (d)    30.00  30.00  30.00  30.00             * FLOW PERIOD    min 15 75 *
* DIA   (m)    36.58  36.58  36.58  36.58             * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP         0      0      0      0             * FLOW PEAK am/op/pm    PM *
*                                                      *                      *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  235  100  120  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  170  205   30  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   35  145   75  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   55  105  135  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                           *                 *
* FLOW         veh     455    405    255    295             *                 *
* CAPACITY     veh    1097   1073   1074   1135             * AVDEL s    5.0 *
* AVE DELAY   mins    0.09   0.09   0.07   0.07             * L  O  S      A *
* MAX DELAY   mins    0.13   0.12   0.09   0.09             * VEH HRS    1.9 *
* AVE QUEUE    veh       1      1      0      0             * COST  $   29.2 *
* MAX QUEUE    veh       1      1      0      0             *                 *
*                                                           *                 *
*******************************************************************************
```

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	LHY
Agency or Company	ATA
Analysis Period/Year	AM PEAK F2010
Comment	FUTURE 2010

Site Information

Jurisdiction/Date	POIPU 8/4/2005
Major Street	POIPU ROAD
Minor Street	KIPUKA STREET

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	35	225			270	25				45		40
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	39	250			300	28				50		44
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	94	525	.179	1	13.3	B	13.3
	2								
	3								B
		1	39	1226	.032	<1	8	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK F2010	Minor Street	KIPUKA STREET
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	45	420			460	50				40		30
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	50	467			511	56				44		33
Flare storage (# of vehs)												0
Median storage (# of vehs)											0	

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	77	295	.261	1	21.4	C	21.4
	2								
	3								C
		1	50	1000	.05	<1	8.8	A	
		4							

```
*******************************************************************************
*                                                                             *
*   4:8:05                   FUT 2010  POIPU/HOOWILI                      12  *
*                                                                             *
*******************************************************************************
*                                                 *                           *
* E     (m)     4.57   4.57   4.57   4.57         * TIME PERIOD    min     90 *
* L'    (m)    10.00  10.00  10.00  10.00         * TIME SLICE     min     15 *
* V     (m)     3.66   3.66   3.66   3.66         * RESULTS PERIOD min  15 75 *
* RAD   (m)    30.00  30.00  30.00  30.00         * TIME COST     $/hr  15.00 *
* PHI   (d)    30.00  30.00  30.00  30.00         * FLOW PERIOD    min  15 75 *
* DIA   (m)    36.58  36.58  36.58  36.58         * FLOW TYPE  pcu/veh    VEH *
* GRAD SEP         0      0      0      0         * FLOW PEAK am/op/pm     AM *
*                                                 *                           *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*   15    5   20  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10  250   30  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   25    5   85  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  125  235   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                           *                 *
* FLOW          veh       40     290     115     370        *                 *
* CAPACITY      veh     1088    1260    1105    1210        * AVDEL s     3.9 *
* AVE DELAY    mins     0.06    0.06    0.06    0.07        * L  O  S       A *
* MAX DELAY    mins     0.07    0.08    0.08    0.09        * VEH HRS     0.9 *
* AVE QUEUE     veh        0       0       0       0        * COST  $    13.1 *
* MAX QUEUE     veh        0       0       0       1        *                 *
*                                                           *                 *
*******************************************************************************
```

```
*************************************************************************
*                                                                       *
*   4:8:05              FUT 2010  POIPU/HOOWILI                     13  *
*                                                                       *
*************************************************************************
*                                               *                       *
* E     (m)    4.57   4.57   4.57   4.57        * TIME PERIOD    min  90 *
* L'    (m)   10.00  10.00  10.00  10.00        * TIME SLICE     min  15 *
* V     (m)    3.66   3.66   3.66   3.66        * RESULTS PERIOD min 15 75 *
* RAD   (m)   30.00  30.00  30.00  30.00        * TIME COST     $/hr 15.00 *
* PHI   (d)   30.00  30.00  30.00  30.00        * FLOW PERIOD    min 15 75 *
* DIA   (m)   36.58  36.58  36.58  36.58        * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP        0      0      0      0        * FLOW PEAK am/op/pm    PM *
*                                               *                       *
*************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*   15    5   15   0         *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   20  425   55   0         *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   75    5  175   0         *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  220  365   20   0         *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*************************************************************************
*                                                        *              *
* FLOW        veh      35    500    255    605           *              *
* CAPACITY    veh     954   1257    992   1143           * AVDEL s  5.5 *
* AVE DELAY  mins    0.06   0.08   0.08   0.11           * L O S      A *
* MAX DELAY  mins    0.08   0.10   0.11   0.16           * VEH HRS  2.1 *
* AVE QUEUE   veh       0      1      0      1           * COST $  32.1 *
* MAX QUEUE   veh       0      1      0      1           *              *
*                                                        *              *
*************************************************************************
```

Knudsen Trust
Village at Poipu
AM Peak Hour of Traffic - Future Year 2010

08/09/05
17:41:25

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA				NONCBD
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	15	5	20	10	250	30	25	5	85	125	235	10
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	12.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	1	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1527	0	0	1852	900	1583	1316	0	0	1766	1080

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	17.00	33.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	8	11					
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 17:41:17
AM Peak Hour of Traffic - Future Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Hoowili Road
Degree of Saturation (v/c) 0.31 Vehicle Delay 9.4 Level of Service A

```
       -------------------------
Sq 11  |   Phase 1   |  Phase 2   |
**/**  -------------------------
       | + + +       |         ^  |
  .    | + + +       |       ++++|
 /|\   |<+ + +>      |      <++++|
  |    |   v         |   ^   ++++|
  |    |       ^     |++++   v   |
North  |    <* * +>|****>         |
  |    |     * * + |****          |
       |     * * + |   v          |
       -------------------------
       | G/C=0.283 | G/C=0.550 |
       | G=  17.0" | G=  33.0" |
       | Y+R= 5.0" | Y+R= 5.0" |
       | OFF= 0.0% | OFF=36.7% |
       -------------------------
       C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								16.0	B	
RT+TH+LT	12/1	0.000	0.283	368	433	45	0.104	16.0	B	27 ft
NB Approach								16.8	B	
RT	12/1	0.059	0.283	366	449	28	0.062	16.0	B	19 ft
TH+LT	12/1	0.116	0.283	311	373	100	0.268	17.1	*B	63 ft
WB Approach								7.3	A	
RT+TH	12/1	0.195	0.550	993	1019	289	0.284	7.4	A	123 ft
LT	12/1	0.000	0.550	456	495	33	0.067	6.4	A	13 ft
EB Approach								8.1	A	
RT+TH	12/1	0.266	0.550	943	971	400	0.412	8.1	*A	185 ft
LT	12/1	0.000	0.550	557	594	11	0.019	6.2	A	4 ft

Knudsen Trust 08/09/05
Village at Poipu 17:43:36
PM Peak Hour of Traffic - Future Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	15	5	15	20	425	55	75	5	175	220	365	20
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	12.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	1	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1508	0	0	1850	536	1583	1310	0	0	1758	757

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	17.00	33.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	8	11					
EXCESS	0						

```
Knudsen Trust                                                    08/09/05
Village at Poipu                                                 17:43:23
PM Peak Hour of Traffic - Future Year 2010


SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int #   0 - Poipu Road/Hoowili Road
     Degree of Saturation (v/c) 0.53  Vehicle Delay  11.8  Level of Service B+

     -------------------------
Sq 11 |  Phase 1   |  Phase 2   |
**/** -------------------------
     | + + +      |        ^   |
  .  | + + +      |       ++++|
 /|\ |<+ + +>     |      <++++|
  |  |   v        |    ^  ++++|
  |  |       ^    |++++   v   |
North |    <* * +>|****>       |
  |  |     * * + |****        |
     |     * * + |   v        |
     -------------------------
     | G/C=0.283 | G/C=0.550 |
     | G=  17.0" | G=  33.0" |
     | Y+R= 5.0" | Y+R= 5.0" |
     | OFF= 0.0% | OFF=36.7% |
     -------------------------
     C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%

------------------------------------------------------------------------------
| Lane    |Width/|     g/C      | Service Rate|  Adj |       | HCM  | L | Queue |
|  Group  | Lanes| Reqd   Used  | @C (vph) @E |Volume|  v/c  | Delay| S |Model 1|
------------------------------------------------------------------------------

SB Approach                                                    15.9   B
==============================================================================
|RT+TH+LT| 12/1 |0.000 |0.283 |   362 |   427 |    40 |0.094 |  15.9 | B |  24 ft|
------------------------------------------------------------------------------

NB Approach                                                    19.0   B
==============================================================================
|   RT   | 12/1 |0.107 |0.283 |   366 |   449 |    83 |0.185 |  17.2 | B |  56 ft|
|   TH+LT| 12/1 |0.200 |0.283 |   309 |   371 |   200 |0.539 |  19.8 |*B | 139 ft|
------------------------------------------------------------------------------

WB Approach                                                     8.5   A
==============================================================================
|RT+TH   | 12/1 |0.303 |0.550 |   991 |  1018 |   494 |0.485 |   8.7 | A | 240 ft|
|   LT   | 12/1 |0.000 |0.550 |   257 |   295 |    61 |0.207 |   7.2 | A |  26 ft|
------------------------------------------------------------------------------

EB Approach                                                    11.3   B+
==============================================================================
|RT+TH   | 12/1 |0.400 |0.550 |   939 |   967 |   650 |0.672 |  11.5 |*B+| 369 ft|
|   LT   | 12/1 |0.000 |0.550 |   378 |   417 |    22 |0.053 |   6.3 | A |   9 ft|
------------------------------------------------------------------------------
```

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK HOUR F2010	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	FUTURE 2010		

Input Data

Lane Configuration	EB			WB			NB			SB		
Lane 1 (curb)	LT			TR						LR		
Lane 2												
Lane 3												
	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	15	350			305	10				15		20
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	17	389			339	11				17		22
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	39	498	.078	<1	12.8	B	12.8
	2								
	3								B
		1	17	1203	.014	<1	8	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst: LHY
Agency or Company: ATA
Analysis Period/Year: PM PEAK HOUR F2010
Comment: FUTURE 2010

Site Information

Jurisdiction/Date: POIPU 8/5/2005
Major Street: POIPU ROAD
Minor Street: KIAHUNA TENNIS CLUB DWY

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	25	565			565	20				20		25
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	28	628			628	22				22		28
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	50	262	.191	1	22	C	22
	2								
	3								C
		1	28	931	.03	<1	9	A	
		4							

```
*******************************************************************************
*                                                                             *
*   4:8:05                 FUT 2010  POIPU/KIAHUNA                       13   *
*                                                                             *
*******************************************************************************
*                                                   *                         *
* E     (m)    4.57   4.57   4.57   4.57            * TIME PERIOD    min    90  *
* L'    (m)   10.00  10.00  10.00  10.00            * TIME SLICE     min    15  *
* V     (m)    3.66   3.66   3.66   3.66            * RESULTS PERIOD min  15 75  *
* RAD   (m)   30.00  30.00  30.00  30.00            * TIME COST     $/hr  15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00            * FLOW PERIOD    min  15 75  *
* DIA   (m)   36.58  36.58  36.58  36.58            * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP        0      0      0      0            * FLOW PEAK am/op/pm    AM  *
*                                                   *                         *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*   55    5   40  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   45  275   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*    5    5    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   40  340   70  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                         *                   *
* FLOW        veh      100    330     15    450           *                   *
* CAPACITY    veh     1039   1213   1091   1268           * AVDEL s      4.1  *
* AVE DELAY  mins     0.06   0.07   0.05   0.07           * L  O  S        A  *
* MAX DELAY  mins     0.08   0.09   0.07   0.09           * VEH HRS      1.0  *
* AVE QUEUE   veh        0      0      0      1           * COST  $     15.4  *
* MAX QUEUE   veh        0      0      0      1           *                   *
*                                                         *                   *
*******************************************************************************
```

```
********************************************************************************
*                                                                              *
*   4:8:05                 FUT 2010  POIPU/KIAHUNA                        14  *
*                                                                              *
********************************************************************************
*                                                   *                          *
* E     (m)     4.57   4.57   4.57   4.57           * TIME PERIOD    min    90  *
* L'    (m)    10.00  10.00  10.00  10.00           * TIME SLICE     min    15  *
* V     (m)     3.66   3.66   3.66   3.66           * RESULTS PERIOD min  15 75  *
* RAD   (m)    30.00  30.00  30.00  30.00           * TIME COST     $/hr  15.00  *
* PHI   (d)    30.00  30.00  30.00  30.00           * FLOW PERIOD    min  15 75  *
* DIA   (m)    36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh   VEH  *
* GRAD SEP         0      0      0      0           * FLOW PEAK am/op/pm    PM  *
*                                                   *                          *
********************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  150   10   75  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  110  475   20  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   20    5   35  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   25  485  135  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
********************************************************************************
*                                                              *               *
* FLOW         veh      235    605     60    645               *               *
* CAPACITY     veh      899   1152    948   1245               * AVDEL s   6.0 *
* AVE DELAY   mins     0.09   0.11   0.07   0.10               * L  O  S     A *
* MAX DELAY   mins     0.12   0.15   0.09   0.14               * VEH HRS   2.6 *
* AVE QUEUE    veh        0      1      0      1               * COST  $  38.6 *
* MAX QUEUE    veh        0      1      0      1               *               *
*                                                              *               *
********************************************************************************
```

Knudsen Trust
Village at Poipu
AM Peak Hour of Traffic - Future Year 2010

08/09/05
16:13:18

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA			NONCBD	
SIMULATION PERIOD			15	
LEVELOFSERVICE		C	S	
NODELOCATION		0	0	
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	40	5	40	40	135	10	5	5	5	30	225	55
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1524	0	0	1799	1090	0	1654	0	0	1830	1184

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	10		PEDTIME	0.0	0
GREENTIMES	17.00	33.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	2	11					
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:13:12
AM Peak Hour of Traffic - Future Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.22 Vehicle Delay 8.7 Level of Service A

```
        -------------------------
Sq 11  |   Phase 1   |   Phase 2   |
**/**   -------------------------
       | * * *       |        ^    |
   .   | * * *       |        ++++|
 /|\   |<* * *>      |       <++++|
  |    |   v         |    ^   ++++|
  |    |        ^    |++++    v    |
North  |    <+ + +>|****>          |
  |    |      + + +  |****         |
       |      + + +  |    v        |
        -------------------------
       | G/C=0.283  | G/C=0.550  |
       | G=  17.0"  | G=  33.0"  |
       | Y+R= 5.0"  | Y+R= 5.0"  |
       | OFF= 0.0%  | OFF=36.7%  |
        -------------------------
       C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								16.7	B	
RT+TH+LT	12/1	0.097	0.283	367	432	94	0.218	16.7	*B	58 ft
NB Approach								15.6	B	
RT+TH+LT	12/1	0.000	0.283	402	468	18	0.038	15.6	B	10 ft
WB Approach								6.9	A	
RT+TH	12/1	0.146	0.550	963	990	194	0.196	6.9	A	79 ft
LT	12/1	0.000	0.550	563	600	11	0.018	6.1	A	4 ft
EB Approach								7.2	A	
RT+TH	12/1	0.194	0.550	980	1007	283	0.281	7.3	*A	120 ft
LT	12/1	0.000	0.550	615	651	61	0.094	6.5	A	24 ft

Knudsen Trust 08/09/05
Village at Poipu 16:14:12
PM Peak Hour of Traffic - Future Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA				NONCBD
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	150	10	75	110	475	20	20	5	35	25	485	135
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1493	0	0	1810	634	0	1381	0	0	1849	515

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	10		PEDTIME	0.0	0
GREENTIMES	18.00	32.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	2	5					
EXCESS	0						

Knudsen Trust 08/09/05
Village at Poipu 16:14:04
PM Peak Hour of Traffic - Future Year 2010

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.59 Vehicle Delay 12.7 Level of Service B+

```
        -------------------------
Sq 11 |  Phase 1   |  Phase 2   |
**/** -------------------------
      | * * *      |        ^   |
  .   | * * *      |        ****|
 /|\  |<* * *>     |      <****|
  |   |   v        |    ^   ++++|
  |   |       ^    |++++    v   |
North |    <+ + +>|++++>        |
  |   |     + + + |++++         |
      |     + + + |   v         |
        -------------------------
      | G/C=0.300 | G/C=0.533 |
      | G=  18.0" | G=  32.0" |
      | Y+R= 5.0" | Y+R= 5.0" |
      | OFF= 0.0% | OFF=38.3% |
        -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								19.7	B	
RT+TH+LT	12/1	0.219	0.300	385	448	261	0.583	19.7	*B	181 ft
NB Approach								15.6	B	
RT+TH+LT	12/1	0.081	0.300	352	414	67	0.162	15.6	B	40 ft
WB Approach								11.9	B+	
RT+TH	12/1	0.390	0.533	935	965	650	0.674	12.1	*B+	375 ft
LT	12/1	0.000	0.533	298	338	22	0.065	6.9	A	9 ft
EB Approach								10.5	B+	
RT+TH	12/1	0.340	0.533	956	986	567	0.575	10.3	B+	301 ft
LT	12/1	0.374	0.533	237	275	150	0.545	11.5	B+	86 ft

APPENDIX C
LEVEL OF SERVICE CALCULATIONS

- **Year 2015** Traffic Operations with Project-Generated Traffic

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK F2015	Minor Street	POIPU ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		455	55	370	260		35		335			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		506	61	411	289		39		372			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	372	543	.686	5	24.9	C	34.4
	2	L	39	64	.61	3	125.8	F	D
	3								
SB	1								
	2								
	3								
		1							
		4	411	1000	.411	2	11.1	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information

Analyst	LHY
Agency or Company	ATA
Analysis Period/Year	PM PEAK F2015
Comment	FUTURE 2015

Site Information

Jurisdiction/Date	POIPU 8/4/2005
Major Street	KOLOA ROAD
Minor Street	POIPU ROAD

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	T	R	
Lane 2		L	L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		540	65	630	600		50		605			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		600	72	700	667		56		672			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	672	476	1.412	32	220.9	F	625.2
	2	L	56	5	10.278	9	5476.4	F	
	3								F
SB	1								
	2								
	3								
		1							
		4	700	914	.766	8	20.6	C	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK F2015	Minor Street	MALUHIA ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	275	550			350	100				100		295
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	306	611			389	111				111		328
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	328	611	.536	3	17.5	C	106.4
	2	L	111	75	1.478	9	369	F	F
	3								
		1	306	1059	.289	1	9.8	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK F2015	Minor Street	MALUHIA ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		R
Lane 2	L			L
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	490	740			795	180				170		495
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	544	822			883	200				189		550
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	R	550	300	1.831	37	415.7	F	9215.5
	2	L	189	3	72.333	26	34823.4	F	F
	3								
		1	544	640	.851	10	34.3	D	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	AM PEAK F2015	Minor Street	ALA KINO IKI
Comment	FUTURE 2015		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		345	5	225	405		5		250			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		383	6	250	450		6		278			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	278	662	.42	2	14.3	B	14.7
	2	L	6	133	.045	<1	33.4	D	B
	3								
EB	1								
	2								
	3								
		1							
		4	250	1164	.215	1	8.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	MALUHIA ROAD
Analysis Period/Year	PM PEAK F2015	Minor Street	ALA KINO IKI
Comment	FUTURE 2015		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	R	T	R	
Lane 2	T	L	L	
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		595	15	380	620		25		370			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		661	17	422	689		28		411			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1	R	411	461	.892	10	49.6	E	72.6
	2	L	28	26	1.06	3	410.2	F	
	3								F
EB	1								
	2								
	3								
		1							
		4	422	909	.464	2	12.3	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	AM PEAK F2015	Minor Street	WELIWELI ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		415	305	70	370		120		90			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		461	339	78	411		133		100			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	100	479	.209	1	14.5	B	42
	2	L	133	185	.719	5	62.8	F	
	3								E
SB	1								
	2								
	3								
		1							
		4	78	819	.095	<1	9.9	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	KOLOA ROAD
Analysis Period/Year	PM PEAK F2015	Minor Street	WELIWELI ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	TR	LT	R	
Lane 2			L	
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)		510	330	125	570		305		115			
PHF		.9	.9	.9	.9		.9		.9			
Proportion of heavy vehicles, HV		3	3	3	3		3		3			
Flow rate		567	367	139	633		339		128			
Flare storage (# of vehs)									0			
Median storage (# of vehs)							0					

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1	R	128	410	.312	1	17.7	C	1037.1
	2	L	339	86	3.936	35	1422	F	
	3								F
SB	1								
	2								
	3								
		1							
		4	139	729	.19	1	11.1	B	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information			Site Information		
Analyst	LHY		Jurisdiction/Date	POIPU	8/4/2005
Agency or Company	ATA		Major Street	WELIWELI ROAD	
Analysis Period/Year	AM PEAK	F2015	Minor Street	HAPA ROAD	
Comment	FUTURE 2015				

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	25	150			310	40				85		65
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	28	167			344	44				94		72
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	72	676	.106	<1	11	B	13.2
	2	L	94	458	.205	1	14.9	B	
	3								B
		1	28	1164	.024	<1	8.2	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	WELIWELI ROAD
Analysis Period/Year	PM PEAK F2015	Minor Street	HAPA ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	NB	SB	WB	EB
Lane 1 (curb)	LT	TR		R
Lane 2				L
Lane 3				

	NB			SB			WB			EB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	65	290			225	95				65		50
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	72	322			250	106				72		56
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
WB	1								
	2								
	3								
EB	1	R	56	735	.076	<1	10.3	B	14.7
	2	L	72	346	.208	1	18.1	C	
	3								B
		1	72	1198	.06	<1	8.2	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	AM PEAK F2015	Minor Street	WELIWELI ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	R	R	R	LTR
Lane 2	LT	LT	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	230	30	140	205	5	55	35	300	5	15	10
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	11	256	33	156	228	6	61	39	333	6	17	11
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	333	781	.427	2	13	B	16.7
	2	LT	100	247	.405	2	29.1	D	
	3								C
WB	1	LTR	34	238	.143	<1	22.6	C	22.6
	2								
	3								C
		1	11	1328	.008	<1	7.7	A	
		4	156	1267	.123	<1	8.2	A	

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/5/2005
Agency or Company	ATA	Major Street	ALA KINO IKI
Analysis Period/Year	PM PEAK F2015	Minor Street	WELIWELI ROAD
Comment	FUTURE 2015		

Input Data

Lane Configuration	SB	NB	EB	WB
Lane 1 (curb)	R	R	R	LTR
Lane 2	LT	LT	LT	
Lane 3				

	SB			NB			EB			WB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	10	300	65	280	340	10	45	25	235	10	40	15
PHF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
Proportion of heavy vehicles, HV	3	3	3	3	3	3	3	3	3	3	3	3
Flow rate	11	333	72	311	378	11	50	28	261	11	44	17
Flare storage (# of vehs)									0			0
Median storage (# of vehs)							0			0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
EB	1	R	261	706	.37	2	13.1	B	80.3
	2	LT	78	63	1.245	6	305.3	F	
	3								F
WB	1	LTR	72	85	.848	4	145	F	145
	2								
	3								F
		1	11	1164	.01	<1	8.1	A	
		4	311	1148	.271	1	9.3	A	

```
******************************************************************************
*                                                                            *
*   4:8:05                  FUT 2015  ALA KINO/WELIWELI                  17  *
*                                                                            *
******************************************************************************
*                                                  *                         *
* E     (m)     4.57   4.57   4.57   4.57          * TIME PERIOD    min    90 *
* L'    (m)    10.00  10.00  10.00  10.00          * TIME SLICE     min    15 *
* V     (m)     3.66   3.66   3.66   3.66          * RESULTS PERIOD min 15 75 *
* RAD   (m)    30.00  30.00  30.00  30.00          * TIME COST     $/hr 15.00 *
* PHI   (d)    30.00  30.00  30.00  30.00          * FLOW PERIOD    min 15 75 *
* DIA   (m)    36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh   VEH *
* GRAD SEP         0      0      0      0          * FLOW PEAK am/op/pm    AM *
*                                                  *                         *
******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*   30  230   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10   15    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*    5  205  140  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  300   35   55  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
******************************************************************************
*                                                             *              *
* FLOW         veh      270     30    350    390              *              *
* CAPACITY     veh     1146   1108   1263   1076              * AVDEL s   4.4 *
* AVE DELAY   mins     0.07   0.05   0.06   0.09              * L  O  S     A *
* MAX DELAY   mins     0.09   0.07   0.08   0.12              * VEH HRS   1.3 *
* AVE QUEUE    veh        0      0      0      1              * COST  $  19.0 *
* MAX QUEUE    veh        0      0      0      1              *              *
*                                                             *              *
******************************************************************************
```

```
*************************************************************************************
*                                                                                   *
*   4:8:05                 FUT 2015  ALA KINO/WELIWELI                          18  *
*                                                                                   *
*************************************************************************************
*                                                    *                              *
* E     (m)     4.57   4.57   4.57   4.57            * TIME PERIOD    min       90  *
* L'    (m)    10.00  10.00  10.00  10.00            * TIME SLICE     min       15  *
* V     (m)     3.66   3.66   3.66   3.66            * RESULTS PERIOD min    15 75  *
* RAD   (m)    30.00  30.00  30.00  30.00            * TIME COST     $/hr   15.00  *
* PHI   (d)    30.00  30.00  30.00  30.00            * FLOW PERIOD    min    15 75  *
* DIA   (m)    36.58  36.58  36.58  36.58            * FLOW TYPE  pcu/veh     VEH  *
* GRAD SEP         0      0      0      0            * FLOW PEAK am/op/pm      PM  *
*                                                    *                              *
*************************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SB LEG   *1.05*   65  300   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   15   40   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   10  340  280  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  235   25   45  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*************************************************************************************
*                                                              *                    *
* FLOW         veh      375     65    630    305               *                    *
* CAPACITY     veh     1076   1074   1245    914               * AVDEL s       5.5  *
* AVE DELAY   mins     0.08   0.06   0.10   0.10               * L  O  S         A  *
* MAX DELAY   mins     0.11   0.07   0.13   0.13               * VEH HRS       2.1  *
* AVE QUEUE    veh        1      0      1      1               * COST  $      31.4  *
* MAX QUEUE    veh        1      0      1      1               *                    *
*                                                              *                    *
*************************************************************************************
```

Knudson Trust 08/10/05
Village at Poipu 11:05:18
AM Peak Hour of Traffic - Future Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	30	230	10	10	15	5	5	205	140	300	35	55
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1831	1097	0	1674	0	0	1856	959	0	1598	0

Phasing Parameters

SEQUENCES	11	11					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	21.00	29.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust
Village at Poipu
AM Peak Hour of Traffic - Future Year 2015

08/10/05
11:05:08

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.46 Vehicle Delay 15.8 Level of Service B

```
       -------------------------
Sq 11  |   Phase 1   |   Phase 2  |
**/**  -------------------------
       | + + +       |        ^   |
  .    | + + +       |       ++++|
 /|\   |<+ + +>      |      <++++|
  |    |   v         |   ^   ++++|
  |    |       ^     |****   v    |
North  |    <* + +>|****>          |
  |    |     * + +   |****          |
       |     * + +   |   v          |
       -------------------------
       | G/C=0.350  | G/C=0.483  |
       | G=  21.0"  | G=  29.0"  |
       | Y+R= 5.0"  | Y+R= 5.0"  |
       | OFF= 0.0%  | OFF=43.3%  |
       -------------------------
```

C= 60 sec G= 50.0 sec = 83.3% Y=10.0 sec = 16.7% Ped= 0.0 sec = 0.0%

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								17.2	B	
RT+TH	12/1	0.210	0.350	569	641	289	0.451	17.3	B	183 ft
LT	12/1	0.000	0.350	314	384	11	0.029	12.9	B+	7 ft
NB Approach								17.5	B	
RT+TH	12/1	0.179	0.350	577	649	234	0.361	16.1	B	145 ft
LT	12/1	0.243	0.350	268	336	156	0.464	19.7	*B	108 ft
WB Approach								8.3	A	
RT+TH+LT	12/1	0.062	0.483	762	809	34	0.042	8.3	A	16 ft
EB Approach								13.9	B+	
RT+TH+LT	12/1	0.319	0.483	724	772	433	0.561	13.9	*B+	251 ft

Knudson Trust
Village at Poipu
pM Peak Hour of Traffic - Future Year 2015

08/10/05
11:06:29

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Ala Kinoiki / Weli Weli Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	65	300	10	15	40	10	10	340	280	235	25	45
WIDTHS	0.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0	0.0	12.0	0.0
LANES	0	1	1	0	1	0	0	1	1	0	1	0
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1813	895	0	1684	0	0	1855	869	0	1580	0

Phasing Parameters

SEQUENCES	11	11					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	30		PEDTIME	0.0	0
GREENTIMES	31.00	19.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	9	11					
EXCESS	0						

Knudson Trust
Village at Poipu
pM Peak Hour of Traffic - Future Year 2015

08/10/05
11:06:20

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Ala Kinoiki / Weli Weli Road
Degree of Saturation (v/c) 0.52 Vehicle Delay 15.6 Level of Service B

```
        ------------------------
Sq 11 |  Phase 1   |  Phase 2   |
**/** ------------------------
       | + + +      |        ^   |
   .   | + + +      |       ++++|
  /|\  |<+ + +>     |      <++++|
   |   |   v        |   ^   ++++|
   |   |        ^   |****    v   |
North |     <* + +>|****>       |
   |   |       * + + |****       |
       |       * + + |   v        |
        ------------------------
       | G/C=0.517  | G/C=0.317  |
       | G=  31.0"  | G=  19.0"  |
       | Y+R= 5.0"  | Y+R= 5.0"  |
       | OFF= 0.0%  | OFF=60.0%  |
        ------------------------
       C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								10.4	B+	
RT+TH	12/1	0.271	0.517	900	937	405	0.432	10.5	B+	206 ft
LT	12/1	0.000	0.517	412	462	11	0.024	7.2	A	5 ft
NB Approach								14.3	B+	
RT+TH	12/1	0.258	0.517	921	958	389	0.406	10.1	B+	195 ft
LT	12/1	0.428	0.517	399	449	311	0.693	19.4	*B	211 ft
WB Approach								15.2	B	
RT+TH+LT	12/1	0.094	0.317	455	533	72	0.135	15.2	B	46 ft
EB Approach								25.1	C+	
RT+TH+LT	12/1	0.269	0.317	422	500	339	0.678	25.1	*C+	250 ft

```
*****************************************************************************
*                                                                           *
*   5:8:05                 FUT 2015  POIPU/ALA KINO                     19  *
*                                                                           *
*****************************************************************************
*                                                 *                         *
* E    (m)    4.57   4.57   4.57   4.57           * TIME PERIOD    min    90 *
* L'   (m)   10.00  10.00  10.00  10.00           * TIME SLICE     min    15 *
* V    (m)    3.66   3.66   3.66   3.66           * RESULTS PERIOD min  15 75 *
* RAD  (m)   30.00  30.00  30.00  30.00           * TIME COST     $/hr  15.00 *
* PHI  (d)   30.00  30.00  30.00  30.00           * FLOW PERIOD    min  15 75 *
* DIA  (m)   36.58  36.58  36.58  36.58           * FLOW TYPE  pcu/veh    VEH *
* GRAD SEP       0      0      0      0           * FLOW PEAK am/op/pm     AM *
*                                                 *                         *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SB LEG   *1.05*  185  155  215  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   60  135   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   15  105   65  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   65  150  145  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*****************************************************************************
*                                                            *              *
* FLOW         veh      555    205    185    360             *              *
* CAPACITY     veh     1071    980   1071   1175             * AVDEL s    5.4 *
* AVE DELAY   mins     0.12   0.08   0.07   0.07             * L  O  S      A *
* MAX DELAY   mins     0.17   0.10   0.09   0.10             * VEH HRS    2.0 *
* AVE QUEUE    veh        1      0      0      0             * COST  $   29.6 *
* MAX QUEUE    veh        1      0      0      1             *              *
*                                                            *              *
*****************************************************************************
```

```
*******************************************************************************
*                                                                             *
*   4:8:05                 FUT 2015  POIPU/ALA KINO                      18   *
*                                                                             *
*******************************************************************************
*                                                  *                          *
* E     (m)     4.57   4.57   4.57   4.57          * TIME PERIOD    min     90  *
* L'    (m)    10.00  10.00  10.00  10.00          * TIME SLICE     min     15  *
* V     (m)     3.66   3.66   3.66   3.66          * RESULTS PERIOD min  15 75  *
* RAD   (m)    30.00  30.00  30.00  30.00          * TIME COST     $/hr  15.00  *
* PHI   (d)    30.00  30.00  30.00  30.00          * FLOW PERIOD    min  15 75  *
* DIA   (m)    36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP         0      0      0      0          * FLOW PEAK am/op/pm     PM  *
*                                                  *                          *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  265  110  140  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  195  310   30  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   40  165   85  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   85  245  220  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                           *                 *
* FLOW         veh      515    535    290    550            *                 *
* CAPACITY     veh      960   1007   1001   1117            * AVDEL s     7.0 *
* AVE DELAY   mins     0.14   0.13   0.08   0.10            * L  O  S       A *
* MAX DELAY   mins     0.20   0.19   0.11   0.15            * VEH HRS     3.7 *
* AVE QUEUE    veh        1      1      0      1            * COST  $    55.1 *
* MAX QUEUE    veh        2      1      0      1            *                 *
*                                                           *                 *
*******************************************************************************
```

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK F2015	Minor Street	KIPUKA STREET
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	35	300			340	20				45		45
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	39	333			378	22				50		50
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ____ ft Movement 5 ____ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	100	449	.223	1	15.3	C	15.3
	2								
	3								C
		1	39	1153	.034	<1	8.2	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK F2015	Minor Street	KIPUKA STREET
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	T	TR		LR
Lane 2	L			
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	55	525			615	45				40		35
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	61	583			683	50				44		39
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ________ ft Movement 5 ________ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	83	206	.404	2	33.9	D	33.9
	2								
	3								D
		1	61	867	.07	<1	9.5	A	
		4							

```
*******************************************************************************
*                                                                             *
*   4:8:05                  FUT 2015  POIPU/HOOWILI                      14   *
*                                                                             *
*******************************************************************************
*                                                 *                           *
* E     (m)    4.57   4.57   4.57   4.57          * TIME PERIOD    min     90   *
* L'    (m)   10.00  10.00  10.00  10.00          * TIME SLICE     min     15   *
* V     (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD min  15 75   *
* RAD   (m)   30.00  30.00  30.00  30.00          * TIME COST     $/hr  15.00   *
* PHI   (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD    min  15 75   *
* DIA   (m)   36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh    VEH   *
* GRAD SEP        0      0      0      0          * FLOW PEAK am/op/pm     AM   *
*                                                 *                           *
*******************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*   10    5   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*    5  325   35  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   25    5   95  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  155  325    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*******************************************************************************
*                                                            *                *
* FLOW         veh      25    365    125    485              *                *
* CAPACITY     veh    1033   1268   1065   1202              * AVDEL s    4.4 *
* AVE DELAY   mins    0.06   0.07   0.06   0.08              * L  O  S      A *
* MAX DELAY   mins    0.07   0.08   0.08   0.11              * VEH HRS    1.2 *
* AVE QUEUE    veh       0      0      0      1              * COST  $   18.2 *
* MAX QUEUE    veh       0      0      0      1              *                *
*                                                            *                *
*******************************************************************************
```

```
********************************************************************************
*                                                                              *
*   4:8:05                 FUT 2015  POIPU/HOOWILI                        15   *
*                                                                              *
********************************************************************************
*                                                 *                            *
* E     (m)    4.57   4.57   4.57   4.57          * TIME PERIOD    min     90  *
* L'    (m)   10.00  10.00  10.00  10.00          * TIME SLICE     min     15  *
* V     (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD min  15 75  *
* RAD   (m)   30.00  30.00  30.00  30.00          * TIME COST     $/hr  15.00  *
* PHI   (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD    min  15 75  *
* DIA   (m)   36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh    VEH  *
* GRAD SEP        0      0      0      0          * FLOW PEAK am/op/pm     PM  *
*                                                 *                            *
********************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*   10    5   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   10  585   65  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   85    5  200  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*  270  470   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
********************************************************************************
*                                                            *                 *
* FLOW         veh       25     660     290     750          *                 *
* CAPACITY     veh      884    1266     896    1123          * AVDEL s     7.6 *
* AVE DELAY   mins     0.07    0.10    0.10    0.17          * L  O  S       A *
* MAX DELAY   mins     0.09    0.14    0.14    0.25          * VEH HRS     3.6 *
* AVE QUEUE    veh        0       1       0       2          * COST  $    54.7 *
* MAX QUEUE    veh        0       1       1       3          *                 *
*                                                            *                 *
********************************************************************************
```

Knudsen Trust 08/09/05
Village at Poipu 17:45:43
AM Peak Hour of Traffic - Future Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	10	5	10	5	325	35	25	5	95	155	325	5
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	12.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	1	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1572	0	0	1858	745	1583	1336	0	0	1773	979

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	10		PEDTIME	0.0	0
GREENTIMES	14.00	36.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	8	11					
EXCESS	0						

Knudsen Trust
Village at Poipu
AM Peak Hour of Traffic - Future Year 2015

08/09/05
17:45:33

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Hoowili Road
Degree of Saturation (v/c) 0.39 Vehicle Delay 8.6 Level of Service A

```
      -------------------------
Sq 11 |  Phase 1   |  Phase 2  |
**/** -------------------------
      | + + +      |        ^  |
  .   | + + +      |      ++++|
 /|\  |<+ + +>     |     <++++|
  |   |   v        |   ^  ++++|
  |   |       ^    |++++   v   |
North |    <* * +>|****>       |
  |   |      * * + |****       |
      |      * * + |   v       |
      -------------------------
      | G/C=0.233  | G/C=0.600 |
      | G=  14.0"  | G=  36.0" |
      | Y+R= 5.0"  | Y+R= 5.0" |
      | OFF= 0.0%  | OFF=31.7% |
      -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								18.0	B	
RT+TH+LT	12/1	0.000	0.233	299	367	28	0.076	18.0	B	18 ft
NB Approach								19.6	B	
RT	12/1	0.059	0.233	280	369	28	0.076	18.4	B	20 ft
TH+LT	12/1	0.125	0.233	249	312	112	0.359	20.0	*B	77 ft
WB Approach								6.1	A	
RT+TH	12/1	0.236	0.600	1099	1115	367	0.329	6.2	A	147 ft
LT	12/1	0.000	0.600	412	447	39	0.087	5.1	A	14 ft
EB Approach								7.2	A	
RT+TH	12/1	0.336	0.600	1046	1064	533	0.501	7.2	*A	243 ft
LT	12/1	0.000	0.600	554	587	6	0.010	4.8	A	2 ft

Knudsen Trust — 08/09/05
Village at Poipu — 17:46:54
PM Peak Hour of Traffic - Future Year 2015

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Hoowili Road

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	10	5	10	10	585	65	85	5	200	270	470	10
WIDTHS	0.0	12.0	0.0	0.0	12.0	12.0	12.0	12.0	0.0	0.0	12.0	12.0
LANES	0	1	0	0	1	1	1	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	2	2	2
ACTUATIONS	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	0	1528	0	0	1858	302	1583	1325	0	0	1761	561

Phasing Parameters

SEQUENCES	11	ALL					
PERMISSIVES	NO	NO	NO	NO	LEADLAGS	NONE	NONE
OVERLAPS	YES	YES	YES	YES	OFFSET	0.00	1
CYCLES	60	120	10		PEDTIME	0.0	0
GREENTIMES	15.00	35.00					
YELLOWTIMES	5.00	5.00					
CRITICALS	8	11					
EXCESS	0						

Knudsen Trust
Village at Poipu
PM Peak Hour of Traffic - Future Year 2015

08/09/05
17:46:47

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Hoowili Road
Degree of Saturation (v/c) 0.66 Vehicle Delay 15.5 Level of Service B

```
       -------------------------
Sq 11 |   Phase 1   |  Phase 2  |
**/** -------------------------
      | + + +       |        ^  |
  .   | + + +       |      ++++|
 /|\  |<+ + +>      |     <++++|
  |   |   v         |   ^  ++++|
  |   |       ^     |++++   v   |
North |    <* * +>|****>        |
  |   |      * * +  |****       |
      |      * * +  |   v       |
       -------------------------
      | G/C=0.250 | G/C=0.583 |
      | G=  15.0" | G=  35.0" |
      | Y+R= 5.0" | Y+R= 5.0" |
      | OFF= 0.0% | OFF=33.3% |
       -------------------------
      C= 60 sec   G= 50.0 sec = 83.3%  Y=10.0 sec = 16.7%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								17.3	B	
RT+TH+LT	12/1	0.000	0.250	316	382	28	0.073	17.3	B	17 ft
NB Approach								24.3	C+	
RT	12/1	0.115	0.250	309	396	94	0.237	19.3	B	66 ft
TH+LT	12/1	0.220	0.250	268	331	228	0.689	26.3	*C+	176 ft
WB Approach								9.0	A	
RT+TH	12/1	0.386	0.583	1064	1084	661	0.610	9.1	A	338 ft
LT	12/1	0.074	0.583	144	176	72	0.409	8.4	A	36 ft
EB Approach								17.8	B	
RT+TH	12/1	0.497	0.583	985	1027	822	0.800	17.9	*B	574 ft
LT	12/1	0.000	0.583	283	327	11	0.034	7.3	A	6 ft

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	AM PEAK F2015	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	15	470			385	10				10		15
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	17	522			428	11				11		17
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	28	409	.068	<1	14.4	B	14.4
	2								
	3								B
		1	17	1116	.015	<1	8.3	A	
		4							

CHAPTER 17 - TWSC - UNSIGNALIZED INTERSECTIONS WORKSHEET

Analysis Summary

General Information		Site Information	
Analyst	LHY	Jurisdiction/Date	POIPU 8/4/2005
Agency or Company	ATA	Major Street	POIPU ROAD
Analysis Period/Year	PM PEAK F2015	Minor Street	KIAHUNA TENNIS CLUB DWY
Comment	FUTURE 2015		

Input Data

Lane Configuration	EB	WB	NB	SB
Lane 1 (curb)	LT	TR		LR
Lane 2				
Lane 3				

	EB			WB			NB			SB		
Movement	1 (LT)	2 (TH)	3 (RT)	4 (LT)	5 (TH)	6 (RT)	7 (LT)	8 (TH)	9 (RT)	10 (LT)	11 (TH)	12 (RT)
Volume (veh/h)	30	720			755	20				20		25
PHF	.9	.9			.9	.9				.9		.9
Proportion of heavy vehicles, HV	3	3			3	3				3		3
Flow rate	33	800			839	22				22		28
Flare storage (# of vehs)												0
Median storage (# of vehs)										0		

Signal upstream of Movement 2 ______ ft Movement 5 ______ ft

Length of study period (h) .25

Output Data

	Lane	Movement	Flow Rate (veh/h)	Capacity (veh/h)	v/c	Queue Length (veh)	Control Delay (s)	LOS	Approach Delay and LOS
NB	1								
	2								
	3								
SB	1	LR	50	160	.312	1	37.3	E	37.3
	2								
	3								E
		1	33	776	.043	<1	9.8	A	
		4							

```
*****************************************************************************
*                                                                           *
*   4:8:05                    FUT 2015  POIPU/KIAHUNA                  13   *
*                                                                           *
*****************************************************************************
*                                               *                           *
* E     (m)    4.57   4.57   4.57   4.57        * TIME PERIOD    min     90 *
* L'    (m)   10.00  10.00  10.00  10.00        * TIME SLICE     min     15 *
* V     (m)    3.66   3.66   3.66   3.66        * RESULTS PERIOD min  15 75 *
* RAD   (m)   30.00  30.00  30.00  30.00        * TIME COST     $/hr  15.00 *
* PHI   (d)   30.00  30.00  30.00  30.00        * FLOW PERIOD    min  15 75 *
* DIA   (m)   36.58  36.58  36.58  36.58        * FLOW TYPE  pcu/veh    VEH *
* GRAD SEP        0      0      0      0        * FLOW PEAK am/op/pm     AM *
*                                               *                           *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *         *
* SB LEG   *1.05*  135    5   90  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*   70  325   10  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   10    5    5  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   45  410  115  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*          *    *                            *    *  *               *         *
*****************************************************************************
*                                                           *               *
* FLOW         veh      230    405     20    570            *               *
* CAPACITY     veh      972   1158   1033   1268            * AVDEL s   4.9 *
* AVE DELAY   mins     0.08   0.08   0.06   0.08            * L  O  S     A *
* MAX DELAY   mins     0.11   0.10   0.07   0.11            * VEH HRS   1.7 *
* AVE QUEUE    veh        0      1      0      1            * COST  $  24.8 *
* MAX QUEUE    veh        0      1      0      1            *               *
*                                                           *               *
*****************************************************************************
```

```
*****************************************************************************
*                                                                           *
*   4:8:05              FUT 2015  POIPU/KIAHUNA                       14    *
*                                                                           *
*****************************************************************************
*                                                 *                         *
* E     (m)    4.57   4.57   4.57   4.57          * TIME PERIOD    min    90  *
* L'    (m)   10.00  10.00  10.00  10.00          * TIME SLICE     min    15  *
* V     (m)    3.66   3.66   3.66   3.66          * RESULTS PERIOD min  15 75 *
* RAD   (m)   30.00  30.00  30.00  30.00          * TIME COST     $/hr  15.00 *
* PHI   (d)   30.00  30.00  30.00  30.00          * FLOW PERIOD    min  15 75 *
* DIA   (m)   36.58  36.58  36.58  36.58          * FLOW TYPE  pcu/veh   VEH  *
* GRAD SEP        0      0      0      0          * FLOW PEAK am/op/pm    PM  *
*                                                 *                         *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*CAPF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SB LEG   *1.05*  230   10  115  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* WB LEG   *1.05*  170  605   20  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NB LEG   *1.05*   25   10   40  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* EB LEG   *1.05*   30  600  235  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*****************************************************************************
*                                                          *                *
* FLOW          veh      355    795     75    865          *                *
* CAPACITY      veh      771   1071    850   1239          * AVDEL s   11.1 *
* AVE DELAY   mins      0.15   0.24   0.08   0.16          * L  O  S      B *
* MAX DELAY   mins      0.22   0.39   0.10   0.25          * VEH HRS    6.5 *
* AVE QUEUE     veh        1      3      0      2          * COST  $   97.1 *
* MAX QUEUE     veh        1      5      0      3          *                *
*                                                          *                *
*****************************************************************************
```

Knudsen Trust
Village at Poipu
AM Peak Hour of Traffic - Future Year 2015 w/Mitigative Measu

08/10/05
11:29:43

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA		NONCBD		
SIMULATION PERIOD			15	
LEVELOFSERVICE		C	S	
NODELOCATION		0	0	
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	135	5	90	70	325	10	10	5	5	45	410	115
WIDTHS	12.0	12.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	1	1	0	1	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	1583	1344	0	1583	1863	1770	0	1596	0	0	1835	1770

Phasing Parameters

SEQUENCES	16	16		
PERMISSIVES	NO	NO	NO	NO
OVERLAPS	YES	YES	YES	YES
CYCLES	60	120	60	
GREENTIMES	10.00	9.00	0.00	26.00
YELLOWTIMES	5.00	5.00	0.00	5.00
CRITICALS	2	12	0	11
EXCESS	0			

LEADLAGS	NONE	NONE
OFFSET	0.00	1
PEDTIME	0.0	0

Knudsen Trust
Village at Poipu
AM Peak Hour of Traffic - Future Year 2015 w/Mitigative Measu

08/10/05
11:29:34

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int #   0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.47 Vehicle Delay 15.6   Level of Service B

```
       ----------------------------------------------------
Sq 16 |  Phase 1   |  Phase 2   |  Phase 3   |  Phase 4   |
**/** ----------------------------------------------------
      | + * *      | +          | +          |        ^   |
  .   | + * *      | +          | +          |       ++++|
 /|\  |<+ * *>     |<+          |<+          |      <++++|
  |   |   v        |    ^   ++++|   ^        |           |
  |   |       ^    |****    v   |++++        |           |
North |    <+ + +>|            |++++>       |****>       |
  |   |      + + + |            |++++        |****       |
      |      + + + |            |   v        |   v       |
       ----------------------------------------------------
      | G/C=0.167  | G/C=0.150  | G/C=0.000  | G/C=0.433  |
      | G=  10.0"  | G=   9.0"  | G=   0.0"  | G=  26.0"  |
      | Y+R= 5.0"  | Y+R= 5.0"  | Y+R= 0.0"  | Y+R= 5.0"  |
      | OFF= 0.0%  | OFF=25.0%  | OFF=48.3%  | OFF=48.3%  |
       ----------------------------------------------------
      C= 60 sec   G= 45.0 sec = 75.0%  Y=15.0 sec = 25.0%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								17.5	B	
RT	12/1	0.153	0.400	570	633	150	0.237	12.8	B+	86 ft
TH+LT	12/1	0.119	0.167	163	221	106	0.473	24.2	*C+	80 ft
NB Approach								21.3	C+	
RT+TH+LT	12/1	0.000	0.167	200	266	23	0.086	21.3	C+	16 ft
WB Approach								12.3	B+	
RT	12/1	0.103	0.433	629	686	78	0.114	10.5	B+	42 ft
TH	12/1	0.233	0.433	759	807	361	0.447	12.3	B+	200 ft
LT	12/1	0.018	0.150	197	265	11	0.042	21.9	C+	8 ft
EB Approach								17.0	B	
RT+TH	12/1	0.311	0.433	747	795	506	0.636	15.0	*B	314 ft
LT	12/1	0.107	0.150	197	265	128	0.483	24.8	*C+	97 ft

Knudsen Trust
Village at Poipu
PM Peak Hour of Traffic - Future Year 2015 w/Mitigative Measu

08/10/05
11:28:31

SIGNAL2000/TEAPAC[Ver 1.11.00] - Summary of Parameter Values

Intersection Parameters for Int # 0 - Poipu Road/Kiahuna Plantation

METROAREA			NONCBD	
SIMULATION PERIOD				15
LEVELOFSERVICE			C	S
NODELOCATION			0	0
QUEUEMODELS	1	90	25	40

Approach Parameters

APPLABELS	SB	WB	NB	EB
GRADES	0.0	0.0	0.0	0.0
PEDLEVELS	0	0	0	0
BIKEVOLUMES	0	0	0	0
PARKINGSIDES	NONE	NONE	NONE	NONE
PARKVOLUMES	20	20	20	20
BUSVOLUMES	0	0	0	0
RIGHTTURNONREDS	0	0	0	0
UPSTREAMVC	0.00	0.00	0.00	0.00

Movement Parameters

MOVLABELS	RT	TH	LT	RT	TH	LT	RT	TH	LT	RT	TH	LT
VOLUMES	230	10	115	170	605	20	25	10	40	30	600	235
WIDTHS	12.0	12.0	0.0	12.0	12.0	12.0	0.0	12.0	0.0	0.0	12.0	12.0
LANES	1	1	0	1	1	1	0	1	0	0	1	1
GROUPTYPES	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM	NORM
UTILIZATIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRUCKPERCENTS	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PEAKHOURFACTORS	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
ARRIVALTYPES	3	3	3	3	3	3	3	3	3	3	3	3
ACTUATIONS	NO	YES	NO	NO	YES	YES	NO	YES	NO	NO	YES	YES
REQCLEARANCES	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
MINIMUMS	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
STARTUPLOST	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
ENDGAIN	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE	0	0	0	0	0	0	0	0	0	0	0	0
INITIALQUEUE	0	0	0	0	0	0	0	0	0	0	0	0
IDEALSATFLOWS	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
FACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DELAYFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NSTOPFACTORS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SATURATIONFLOWS	1583	1295	0	1583	1863	1770	0	1352	0	0	1850	1770

Phasing Parameters

SEQUENCES	16	16		
PERMISSIVES	NO	NO	NO	NO
OVERLAPS	YES	YES	YES	YES
CYCLES	60	120	30	
GREENTIMES	9.00	5.00	1.00	25.00
YELLOWTIMES	5.00	5.00	5.00	5.00
CRITICALS	2	6	12	5
EXCESS	0			

LEADLAGS	NONE	NONE
OFFSET	0.00	1
PEDTIME	0.0	0

Knudsen Trust
Village at Poipu
PM Peak Hour of Traffic - Future Year 2015 w/Mitigative Measu

08/10/05
11:28:21

SIGNAL2000/TEAPAC[Ver 1.11.00] - Capacity Analysis Summary

Intersection Averages for Int # 0 - Poipu Road/Kiahuna Plantation
Degree of Saturation (v/c) 0.69 Vehicle Delay 21.9 Level of Service C+

```
      ------------------------------------------------
Sq 16 |  Phase 1  |  Phase 2   |  Phase 3  |  Phase 4  |
**/** ------------------------------------------------
      | + * *     | +          | +         |        ^  |
  .   | + * *     | +          | +         |      ++++|
 /|\  |<+ * *>    |<+          |<+         |     <****|
  |   |   v       |    ^   ****|    ^      |           |
  |   |       ^   |++++   v    |****       |           |
North |    <+ + +>|            |++++>      |++++>      |
  |   |     + + + |            |++++       |++++       |
      |     + + + |            |    v      |    v      |
      ------------------------------------------------
      | G/C=0.150 | G/C=0.083  | G/C=0.017 | G/C=0.417 |
      | G=   9.0" | G=   5.0"  | G=   1.0" | G=  25.0" |
      | Y+R= 5.0" | Y+R= 5.0"  | Y+R= 5.0" | Y+R= 5.0" |
      | OFF= 0.0% | OFF=23.3%  | OFF=40.0% | OFF=50.0% |
      ------------------------------------------------
      C= 60 sec   G= 40.0 sec = 66.7%  Y=20.0 sec = 33.3%  Ped= 0.0 sec =  0.0%
```

Lane Group	Width/ Lanes	g/C Reqd	g/C Used	Service Rate @C (vph)	Service Rate @E	Adj Volume	v/c	HCM Delay	L S	Queue Model 1
SB Approach								21.8	C+	
RT	12/1	0.219	0.417	600	660	256	0.388	13.9	B+	150 ft
TH+LT	12/1	0.153	0.150	137	188	139	0.716	36.2	*D+	119 ft
NB Approach								24.4	C+	
RT+TH+LT	12/1	0.098	0.150	144	198	83	0.409	24.4	C+	63 ft
WB Approach								23.2	C+	
RT	12/1	0.178	0.417	600	660	189	0.286	12.7	B+	107 ft
TH	12/1	0.391	0.417	725	776	672	0.866	26.1	*C+	519 ft
LT	12/1	0.028	0.083	93	137	22	0.150	26.0	*C+	17 ft
EB Approach								20.5	C+	
RT+TH	12/1	0.407	0.517	923	956	700	0.732	14.2	B+	433 ft
LT	12/1	0.188	0.183	253	324	261	0.806	37.3	*D+	224 ft

APPENDIX D

DEFINITION FOR CIRCULAR INTERSECTIONS

APPENDIX D

Definitions for Circular Intersections

There are significant differences between the various types of circular intersections: roundabouts, rotaries (sometimes referred to as "large traffic circles") and "neighborhood" traffic circles, since each type of circular intersection has significantly different operating characteristics and capacity.

Neighborhood traffic circles are small circular islands with diameters generally smaller than 20 feet, retrofitted into existing intersections primarily as a traffic calming device in low volume (3,000 to 5,000 vehicles per day) residential areas. Neighborhood traffic circles are widely used in the State of Washington as traffic calming devices.

Rotaries have very large diameters, usually greater than 300 hundred feet, as they are designed to accommodate long weaving sections between entry points, as traffic in the circle must yield to vehicles entering the rotary. Rotaries are prone to gridlock during periods of high traffic volume such as during the peak hours of traffic. Rotaries are no longer considered as an acceptable type of intersection configuration.

Roundabouts are designed based on gap acceptance, which allows the use of smaller diameter circles, ranging from 45 to 200 feet, as compared to rotaries but they are larger than neighborhood traffic circles. Roundabouts have significantly higher capacity (10,000 to 20,000 vehicles per day) than neighborhood traffic circles and rotaries and also calm traffic speeds as a by-product of their design. Roundabouts can also operate as well as or better than standard unsignalized or signalized intersection configurations. Roundabouts - An Informational Guide, published by the Federal Highway Administration, endorses the use of roundabouts and defines that the following characteristics must be present to meet the definition of a roundabout:

1. Yield control on all entries.
2. Priority to circulating vehicles.
3. Pedestrian access is allowed only across the legs of the roundabout, behind the yield line.
4. Splitter islands on the approaches to separate traffic moving in opposite directions, to deflect entering traffic and to provide pedestrians the opportunity to cross the road in two stages.
5. No parking is allowed within the circulatory roadway or at the entries.
6. All vehicles circulate counterclockwise and pass to the right of the central island.

Appendix M

D. L. ADAMS ASSOCIATES, LTD.
Consultants in Acoustics and Performing Arts Technologies

Environmental Noise Assessment Report
Village at Poipu
Poipu, Kauai, Hawaii

August 2005

DLAA Project No. 04-85

Prepared for:
Eric A. Knudsen Trust
Kalaheo, Hawaii

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APPENDIX

1.0 EXECUTIVE SUMMARY

1.1 The Village at Poipu is located in Poipu, on the southern coast of Kauai, Hawaii. Approximately 350 residential units and 153 additional dwelling units are planned for the residential village, consisting of single-family and multi-family units.

1.2 The dominant noise sources during the project construction phase will probably be earth moving equipment, such as bulldozers and diesel powered trucks. Noise from construction activities will occur on the project site. Noise from construction activities should be short term and must comply with State of Hawaii Community Noise Control Rules and the construction noise permit issued by the Department of Health.

1.3 The results of the vehicular traffic noise analyses are based on traffic data for the year 2015 and show small increases in traffic noise levels at both noise prediction locations due to the project. However, these increases are less than 1 dB and are not deemed significant. In addition, all existing and future predicted noise levels are below the FHWA/HDOT maximum noise limit of 67 dBA. Therefore, no significant traffic noise impact was found regarding the FHWA/HDOT noise criteria.

1.4 The project area is relatively quiet. Noise measurements taken on the existing project property show a Day-Night Level, L_{dn}, of 53 dBA. These noise levels are well below the HUD noise guideline and EPA noise deign goal of $L_{dn} \leq 65$ dBA. In addition the EPA future noise design goal of $L_{dn} \leq 55$ dBA is also satisfied. Therefore, no significant noise impact was found regarding HUD and EPA noise guidelines and design goals.

2.0 PROJECT DESCRIPTION

The Village at Poipu is located in Poipu, on the southern coast of Kauai, Hawaii. Approximately 350 residential units and 153 additional dwelling units are planned for the residential village, consisting of single-family and multi-family units. The project site is 203 acres of undeveloped land and is located north (mauka) of Poipu Road and east of Ala Kinoiki Road.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 State of Hawaii, Community Noise Control

The State of Hawaii Community Noise Control Rule [Reference 1] defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to *stationary* noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc. The Community Noise Control Rule does not specifically address most *moving* sources, such as vehicular traffic noise, air traffic noise, or rail traffic noise. However, the Community Noise Control Rule does include equipment related to agricultural, construction, and industrial activities, which may not be stationary.

These maximum permissible noise levels are enforced by the State Department of Health (DOH) for any location at or beyond the property line and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 1. With respect to mixed zoning districts, the rule specifies that the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level. In determining the maximum permissible sound level, the background noise level is taken into account by the DOH.

3.2 U.S. Federal Highway Administration (FHWA)

The FHWA defines four land use categories and assigns corresponding maximum hourly equivalent sound levels, $L_{eq(h)}$, for traffic noise exposure [Reference 2], which are listed in Figure 2. For example, Category B, defined as picnic and recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67dBA and a maximum interior L_{eq} of 52 dBA. These limits are viewed as design goals, and all projects meeting these limits are deemed in conformance with FHWA noise standards. Calculation of traffic noise levels should be conducted using the Federal Highway Administration's Traffic Noise Model, 1978 [Reference 3] or the Federal Highway Administration's Traffic Noise Model Look-up Tables Software, 2004 [Reference 4].

3.3 Hawaii Department of Transportation (HDOT)

The HDOT has adopted FHWA's design goals for traffic noise exposure in its noise analysis and abatement policy [Reference 5]. According to the policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15 dB.

3.4 U.S. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 6]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

3.5 U.S. Department of Housing and Urban Development (HUD)

HUD's environmental noise criteria and standards in 24 CFR 51 [Reference 7] were established for determining housing project site acceptability. These standards are based on day-night equivalent sound levels, L_{dn}, and are not limited to traffic noise exposure. However, for project sites in the vicinity of highways, the L_{dn} may be estimated to be equal to the design hour $L_{eq\,(h)}$, provided "heavy trucks (vehicles with three or more axles) do not exceed 10 percent of the total traffic flow in vehicles per 24 hours and the traffic flow between 10:00 p.m. and 7:00 a.m. does not exceed 15 percent of the average daily traffic flow in vehicles per 24 hours." For these same conditions, L_{dn}, may also be estimated as 3 dB less than the design hour L_{10}.

HUD site acceptability criteria rank sites as Acceptable, Normally Unacceptable, or Unacceptable. "Acceptable" sites are those where exterior noise levels do not exceed an L_{dn} of 65 dBA. Proposed housing projects on "Acceptable" sites do not require additional noise attenuation other than that provided by customary building techniques. "Normally Unacceptable" sites are those where the L_{dn} is above 65 dBA, but does not exceed 75 dBA. Housing on "Normally Unacceptable" sites requires some form of noise abatement, either at the property line or in the building construction, to ensure the interior noise levels are acceptable. "Unacceptable" sites are those where the L_{dn} is 75 dBA or higher. The term "Unacceptable" does not necessarily mean that housing cannot be built on those sites; however, more elaborate sound attenuation will likely be needed.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

Two types of noise measurements were conducted to assess the existing acoustical environment in the vicinity of the project location. The first noise measurement type consisted of continuous long-term ambient noise level measurements (Location L1 and L2), as shown in Figure 3. The second type of noise measurement was short-term and included traffic counts (Location S1 and S2), also shown in Figure 3. The purpose of the short-term noise measurement and corresponding traffic counts was to calibrate the traffic noise prediction calculations. All noise measurements were conducted between August 3, 2005 and August 4, 2005.

4.1 Noise Measurement Procedure

Long-Term Noise Measurement Procedure
Continuous, hourly, statistical sound levels were recorded for 24 hours. The measurements were taken using a Larson-Davis Laboratories, Model 820, Type-1 Sound Level Meter together with a Larson-Davis, Model 2560 Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period.

The microphone was mounted on a tripod, approximately 6 feet above grade. A windscreen covered the microphone during the entire measurement period. The sound level meter was secured in a weather resistant case.

Short-Term Noise Measurement Procedure
An approximate 20-minute equivalent sound level, L_{eq}, was measured. Vehicular traffic counts and traffic mix were documented during the measurement period. The noise measurement was taken using a Larson-Davis Laboratories, Model 824, Type-1 Sound Level Meter together with a Larson-Davis, Model 2541 Type-1 Microphone. Calibration was checked before and after the measurements with a Larson-Davis Model CAL200 calibrator. Both the sound level meter and the calibrator have been certified by the manufacturer within the recommended calibration period.

The microphone and sound level meter were mounted on a tripod, approximately 6 feet above grade. A windscreen covered the microphone during the entire measurement period.

4.2 Noise Measurement Locations

Long-Term Noise Measurement Locations
Location L1: Positioned adjacent to Kiahuna Plantation Drive at the western edge of the proposed project site, approximately 150 feet east of the edge-of-pavement and 200 feet north of the edge-of-pavement from the paved access road.

Location L2: Positioned adjacent to Poipu Road at the southern edge of the project site, approximately 225 feet north of the edge-of-pavement.

Short-Term Noise Measurement Locations
Location S1: Positioned adjacent to Ala Kinoiki Road, approximately 50 feet west of the edge-of-pavement.

Location S2: Positioned adjacent to Poipu Road, approximately 50 feet north of the edge-of-pavement.

4.3 Long-Term Noise Measurement Results

The results from the long-term noise measurements are graphically presented in Figures 4 and 5, which show the measured equivalent sound level, L_{eq}, in A-weighted decibels (dBA) as a function of the measurement date and time.

The measured sound levels vary with the time of day at both measurement locations. The hourly L_{eq} noise levels at Location L1 generally range from 37 dBA during the night to approximately 50 dBA during the afternoon hours. Due to equipment malfunction, sound measurement data after 11:00 p.m. on August 3, 2005 is not available at this location.

The hourly L_{eq} noise levels at Location L2 generally range from 41 dBA during the night and early morning hours to approximately 54 dBA during the daytime hours. The Average Day-Night Level, L_{dn}, was calculated from the measured noise levels to be 53 dBA.

The dominant and secondary noise sources were similar for both locations and are described below:

Noise Sources

Dominant: Vehicular traffic, birds, and wind.

Secondary: Pedestrian Traffic (L2 only), dogs barking, farm animals, and light rain.

4.4 Existing Vehicular Traffic Noise

Noise levels generated by existing vehicular traffic were calculated using the FHWA Traffic Noise Model Look-up Tables Software Version 2.5 (2004) [Reference 4]. The traffic noise analysis is based on the traffic counts provided by Austin, Tsutsumi & Associates, Inc. [Reference 8]. Existing traffic noise levels were calculated for 4 locations, Locations A, B, C, and D as shown in Figure 3. The short-term noise measurements and corresponding traffic counts were used to calibrate the TNM Look-up Tables software. The results of the TNM Look-up Tables software for the existing traffic are shown in Table 1.

5.0 POTENTIAL NOISE IMPACTS DUE TO THE PROJECT

5.1 Project Construction Noise

Development of project areas will involve excavation, grading, and other typical construction activities during construction. The various construction phases of the project may generate significant amounts of noise. The actual noise levels produced during construction will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 6. Earthmoving equipment, e.g., bulldozers and diesel-powered trucks, will probably be the loudest equipment used during construction, assuming that pile driving will not be required.

5.2 Project Generated Stationary Mechanical Noise & Compliance with State of Hawaii Community Noise Control Rule

The new buildings will incorporate stationary mechanical equipment that is typical for residential housing. Expected mechanical equipment may include air handling equipment, condensing units, etc. Noise from this mechanical equipment and other equipment must meet the State noise rules, which stipulate maximum permissible noise limits at the property line. These noise limits are 55 dBA during the daytime hours (7:00 am to 10:00 pm) and 45 dBA during the night time hours (10:00 pm to 7:00 am) for single-family housing. For multi-family dwellings, the noise limits are 60 dBA during the daytime hours and 50 dBA during the night time hours.

5.3 Projection of Project Generated Vehicular Traffic Noise

A vehicular traffic noise analysis was completed for the existing conditions (see Section 4.4 of this report), and future year 2015 projections, both with and without the project. A map of noise prediction Locations A, B, C, and D is shown in Figure 3. The results of the traffic noise analysis are shown in Table 1. The table shows that the increase in vehicular traffic noise due to the project is less than 1 dB at all noise prediction locations.

5.4 Compliance with FHWA/HDOT Land Use Noise Limits

5.4.1 Vehicular Traffic Noise Impacts on the Surrounding Community

Noise predictions at Locations A, B, C, and D satisfy the FHWA/HDOT maximum noise limit of 67 dBA for the surrounding residential properties along Poipu Road between Kiahuna Plantation Road and Ala Kinoiki Road. In addition, the increase in traffic noise level due to the project is less than 1 dB at all noise prediction locations. Therefore, a significant noise impact on the surrounding community due to project generated traffic noise is not expected.

5.4.2 Vehicular Traffic Noise Impacts on the Project

Noise level projections at the Village at Poipu are predicted to be below the FHWA/HDOT maximum noise limits. Therefore, a significant noise impact on the project due to vehicular traffic noise is not expected.

5.5 Compliance with HUD and EPA Noise Guidelines

The results from the long-term noise measurements conducted at the proposed project site show a calculated Day-Night Level, L_{dn}, of 53 dBA. Therefore, the noise levels at the proposed Village at Poipu are within the HUD noise guidelines, which state a design goal of $L_{dn} \leq 65$ dBA for the exterior noise level. The EPA has an existing design goal of $L_{dn} \leq 65$ dBA and a future design goal $L_{dn} \leq 55$ dBA for exterior noise levels. Therefore the noise levels at the proposed project site are within the EPA existing and future design goals.

It is important to note that the HUD and EPA noise guidelines are design goals and not enforceable regulations, although the HUD noise guidelines must be satisfied for projects involving HUD or federal financing. However, these guidelines and design goals are useful tools for assessing the noise environment.

6.0 NOISE IMPACT MITIGATION

6.1 Mitigation of Construction Noise

In cases where construction noise exceeds, or is expected to exceed the State's "maximum permissible" property line noise levels [Reference 1], a permit must be obtained from the State DOH to allow the operation of vehicles, cranes, construction equipment, power tools, etc., which emit noise levels in excess of the "maximum permissible" levels.

In order for the State DOH to issue a construction noise permit, the Contractor must submit a noise permit application to the DOH, which describes the construction activities for the project. Prior to issuing the noise permit, the State DOH may require action by the Contractor to incorporate noise mitigation into the construction plan. The DOH may also require the Contractor to conduct noise monitoring or community meetings inviting the neighboring residents and business owners to discuss construction noise. The Contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on diesel and gasoline engine machines, using properly tuned and balanced machines, etc. However, the State DOH may require additional noise mitigation, such as temporary noise barriers, or time of day usage limits for certain kinds of construction activities.

Specific permit restrictions for construction activities [Reference 1] are:

"No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels ... before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."

“No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels... before 9:00 a.m. and after 6:00 p.m. on Saturday."

“No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The use of hoe rams and jack hammers 25 lbs. or larger, high pressure sprayers, chain saws, and pile drivers must be restricted to 9:00 a.m. to 5:30 p.m., Monday through Friday. In addition, construction equipment and on-site vehicles or devices whose operations involve the exhausting of gas or air, excluding pile hammers and pneumatic hand tools weighing less than 15 pounds, must be equipped with mufflers [Reference 3].

The DOH noise permit does not limit the noise *level* generated at the construction site, but rather the *times* at which noisy construction can take place. Therefore, noise mitigation for construction activities should be addressed using project management, such that the time restrictions within the DOH permit are followed.

6.2 Mitigation of Project Generated Mechanical Noise

The design of the new Village at Poipu should give consideration to controlling the noise emanating from stationary mechanical equipment, such as chillers, compressors, air conditioning units, etc. so as to comply with the State of Hawaii *Community Noise Control* rules [Reference 1]. Noisy equipment should be located away from neighbors and residential units, as much as is practical. Enclosed mechanical rooms may be required for some equipment.

6.3 Mitigation of Vehicular Traffic Noise

The traffic noise analysis shows no significant noise impacts to the surrounding community, or at the proposed Village at Poipu site. Therefore, noise mitigation for vehicular traffic noise should not be required.

REFERENCES

1. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.

2. *Department of Transportation, Federal Highway Administration Procedures for Abatement of Highway Traffic Noise*, Title 23, CFR, Chapter 1, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; Revised at 47 FR 29654, July 8, 1982.

3. *Federal Highway Administration's Traffic Noise Model*, FHWA-RD-77-108; U.S. Department of Transportation, December 1978.

4. *Federal Highway Administration's Traffic Noise Model Look-up Tables Software*, Ver. 2.5; U.S. Department of Transportation, December 17, 2004.

5. *Noise Analysis and Abatement Policy*, Department of Transportation, Highways Division, State of Hawaii, June 1977.

6. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.

7. *Department of Housing and Urban Development Environmental Criteria and Standards,* Title 24 CFR, Part 51, 44 FR 40860, July 12, 1979, Amended by 49 FR 880, January 6, 1984.

8. *Village at Poipu Traffic Impact Analysis Report,* Austin, Tsutsumi & Associates, Inc., August, 2005.

TABLE 1
Predicted Traffic Noise Levels With and Without the Project and Resulting Increases Due to the Project+

Noise levels shown in the table are based on peak-hour traffic volumes, and are expressed in A-weighted decibels (dBA).

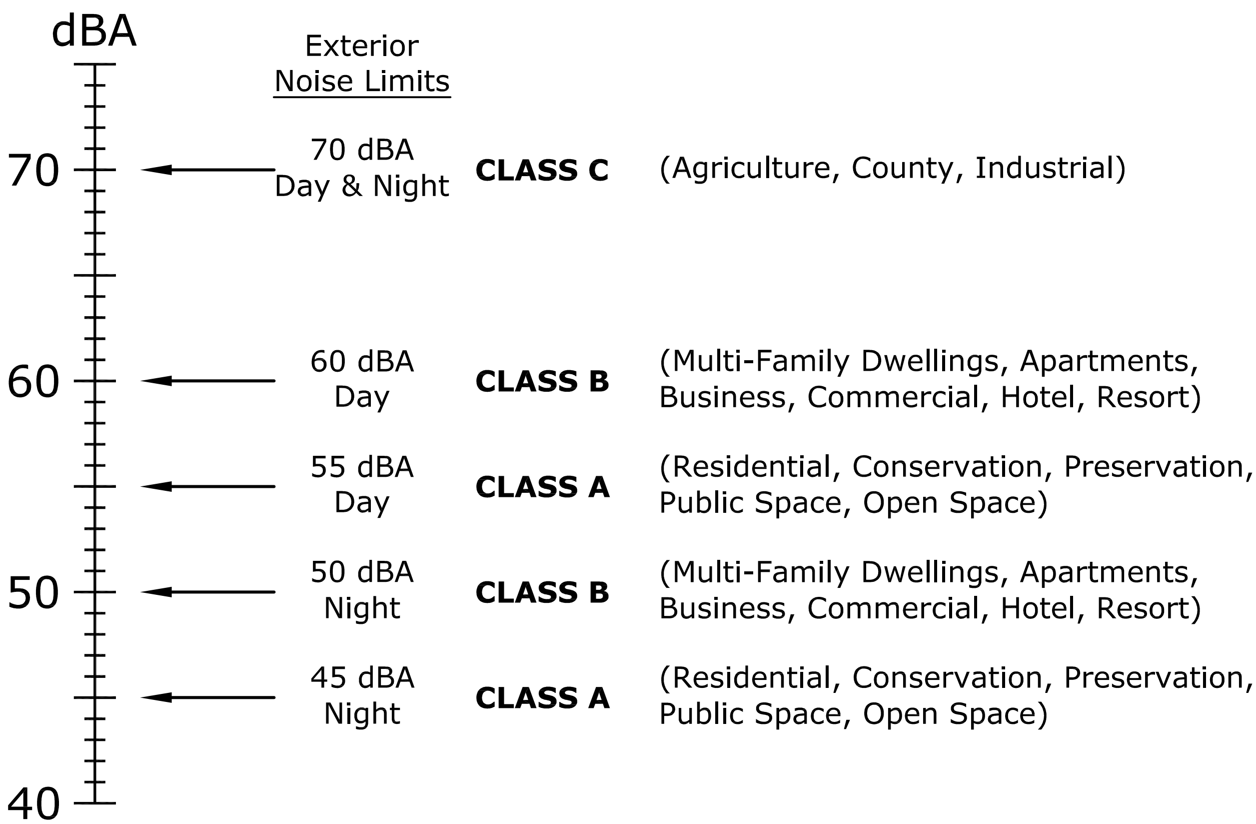
	Location A		**Location B**		**Location C**		**Location D**	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Existing (Calculated)	53.0	53.0	60.0	60.7	N/A	N/A	N/A	N/A
Future Without Project (2015)	56.1	56.1	62.4	63.9	59.0	57.2	59.0	57.2
Future With Project (2015)	56.2	56.2	62.6	64.0	59.7	58.0	59.7	58.0

Comparison of Noise Level Increase from Existing Levels to Predicted Levels With and Without Project

	Location A		**Location B**		**Location C**		**Location D**	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Future Increase Without Project (2015)	3.1	2.8	2.4	3.2	N/A	N/A	N/A	N/A
Future Increase With Project (2015)	3.2	2.9	2.6	3.3	N/A	N/A	N/A	N/A
Future Increase Due to Project (2015)	**0.1**	**0.1**	**0.2**	**0.2**	**0.7**	**0.8**	**0.7**	**0.8**

+ The noise level calculations were based on the traffic study provided by the Austin, Tsutsumi & Associates, Inc. [Reference 8].

Zoning District	Day Hours (7 AM to 10 PM)	Night Hours (10 PM to 7 AM)
CLASS A Residential, Conservation, Preservation, Public Space, Open Space	55 dBA (Exterior)	45 dBA (Exterior)
CLASS B Multi-Family Dwellings, Apartments, Business, Commercial, Hotel, Resort	60 dBA (Exterior)	50 dBA (Exterior)
CLASS C Agriculture, Country, Industrial	70 dBA (Exterior)	70 dBA (Exterior)



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Hawaii Maximum Permissible Sound Levels for Various Zoning Districts

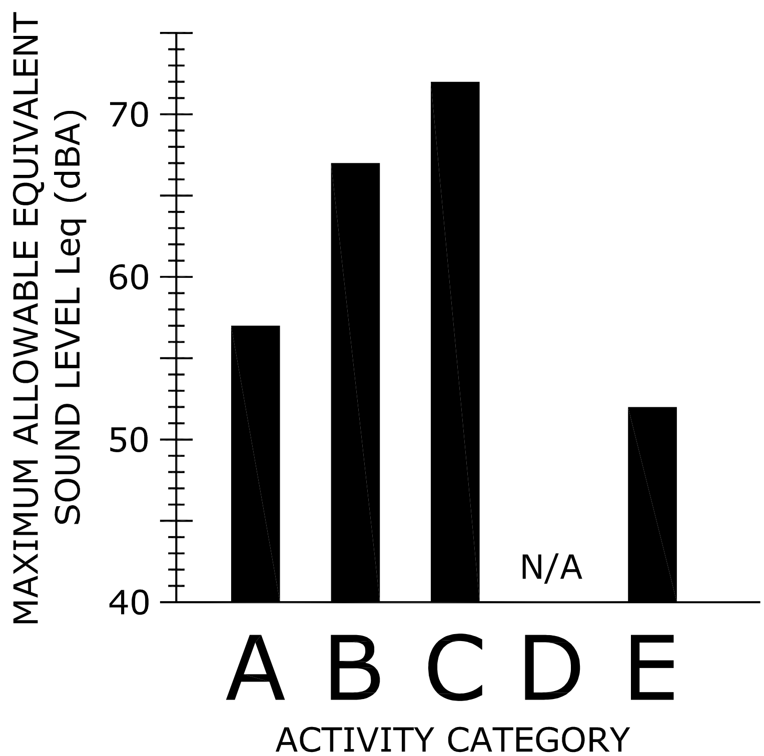
Village at Poipu

Not to Scale

Date August 2005 | Project No. 04-85 | Drawn By TRB

Figure No 1

ACTIVITY CATEGORY	ACTIVITY CATEGORY DESCRIPTION	MAXIMUM EQUIVALENT SOUND LEVEL $L_{eq(h)}$
A	LANDS ON WHICH SERENITY AND QUIET ARE OF EXTRAORDINARY SIGNIFICANCE AND SERVE AN IMPORTANT PUBLIC NEED AND WHERE THE PRESERVATION OF THOSE QUALITIES IS ESSENTIAL IF THE AREA IS TO CONTINUE TO SERVE ITS INTENDED PURPOSE.	57 dBA (EXTERIOR)
B	PICNIC AREAS, RECREATION AREAS, PLAYGROUNDS, ACTIVE SPORT AREAS, PARKS, RESIDENCES, MOTELS, HOTELS, SCHOOLS, CHURCHES, LIBRARIES, AND HOSPITALS.	67 dBA (EXTERIOR)
C	DEVELOPED LANDS, PROPERTIES, OR ACTIVITIES NOT INCLUDED IN ACTIVITY CATEGORIES A OR B ABOVE.	72 dBA (EXTERIOR)
D	UNDEVELOPED LAND	N/A
E	RESIDENCES, MOTELS, HOTELS, PUBLIC MEETING ROOMS, SCHOOLS, CHURCHES, LIBRARIES, HOSPITALS, AND AUDITORIUMS.	52 dBA (INTERIOR)



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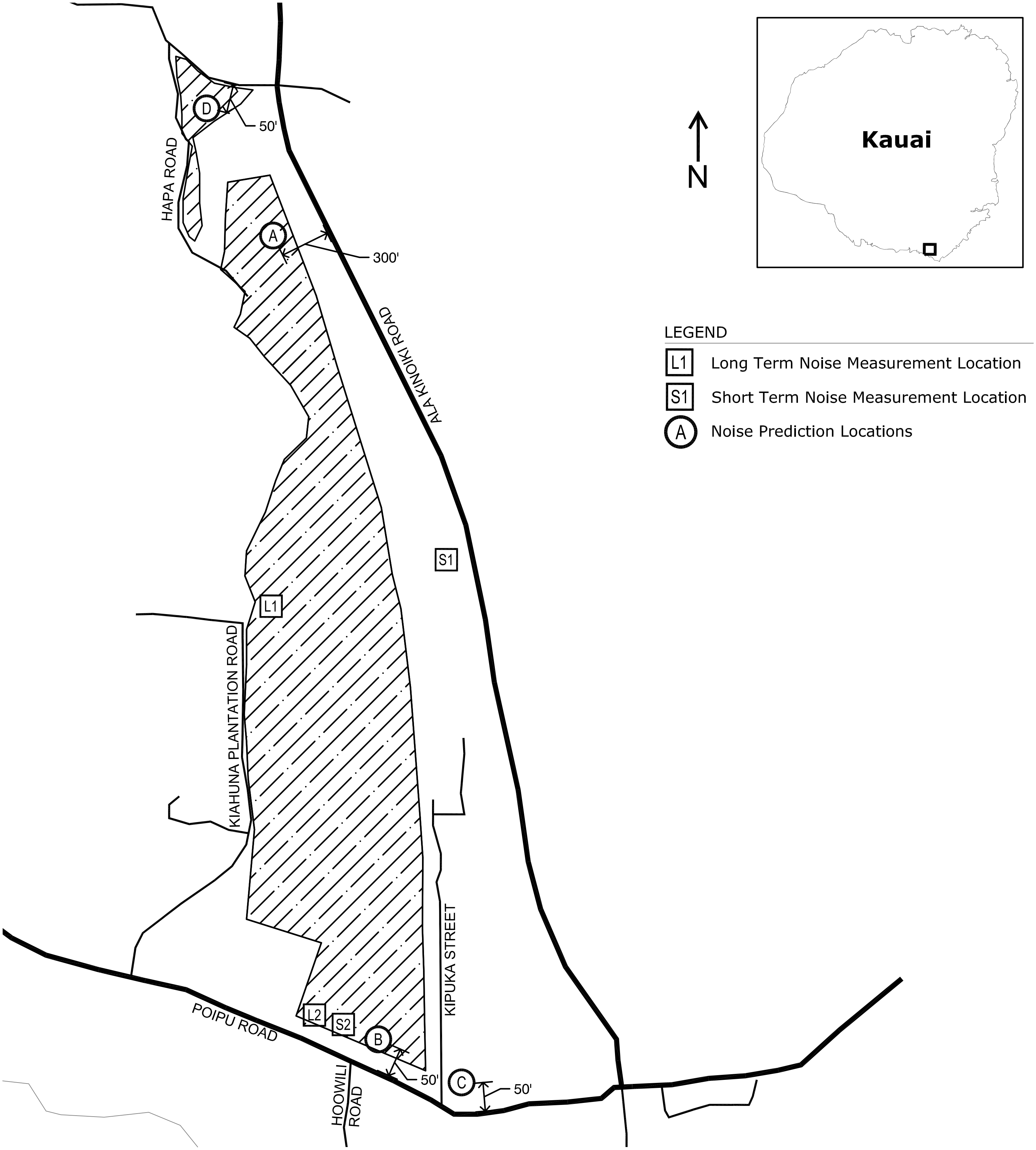
Federal Highways Administration Recommended Equivalent Hourly Sound Levels Based on Land Use

Village at Poipu

Not to Scale

Date	Project No.	Drawn By	Figure No
August 2005	04-85	TRB	2



Noise Measurement and Prediction Locations

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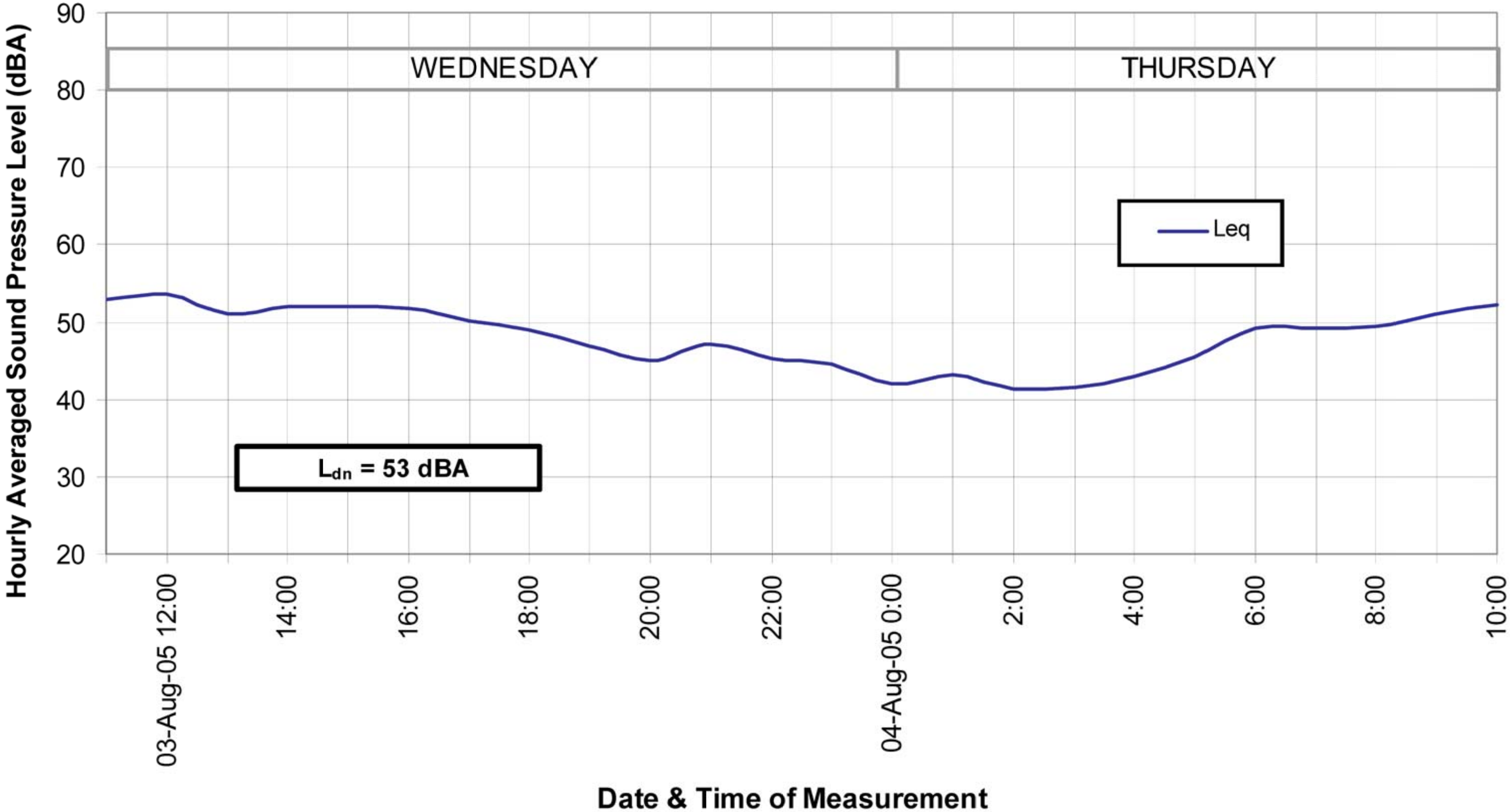
Village at Poipu

Not to Scale

Figure No 3

Date	Project No.	Drawn By
August 2005	04-85	DFD



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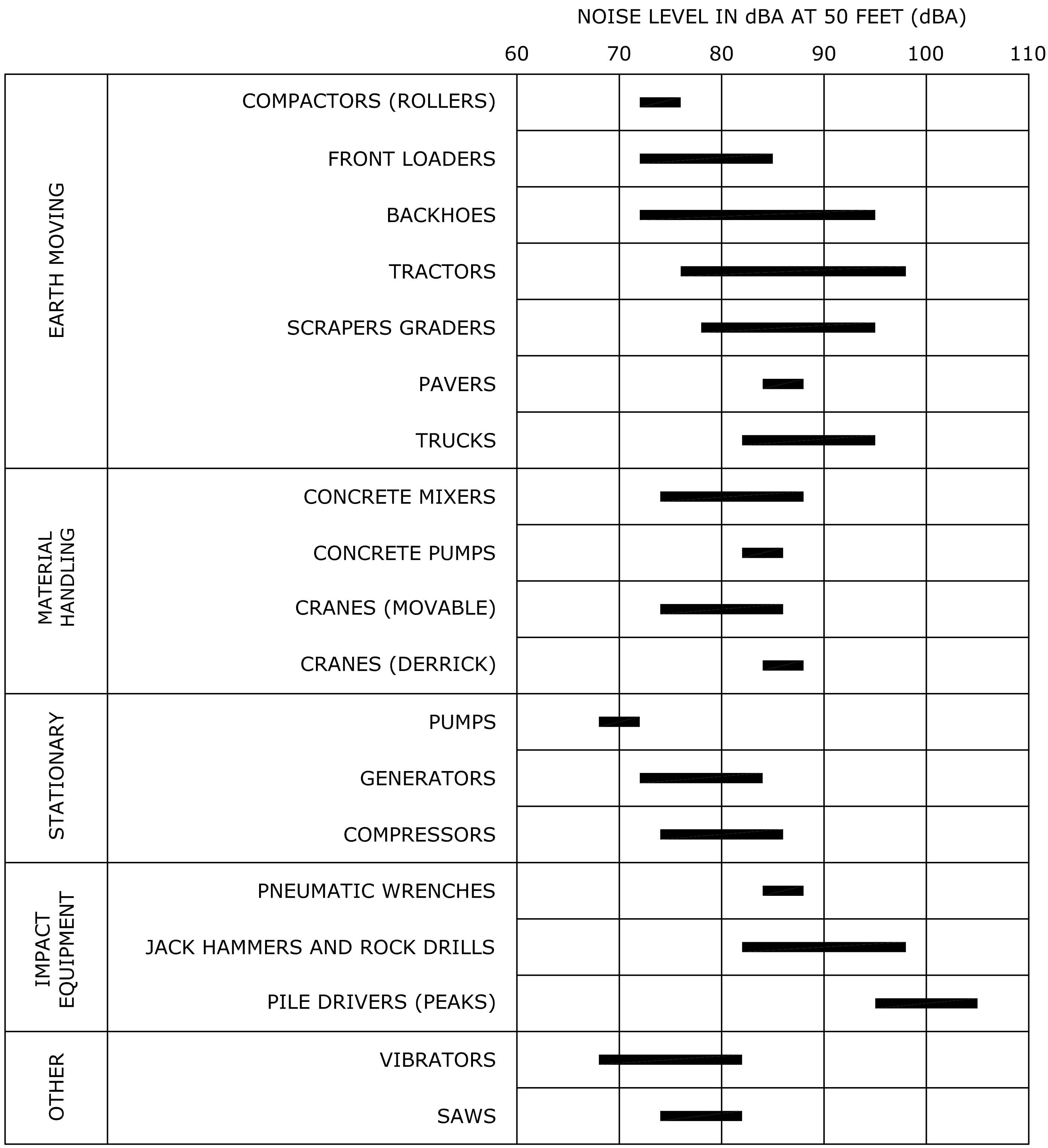
Graph of Long Term Noise Measurements - Location 2

Village at Poipu

not to scale

Date	Project No.	Drawn By	Figure No
August 2005	04-85	DFD	4



NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

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Typical Sound Levels from Construction Equipment

Village at Poipu

Not to Scale

Date	Project No.	Drawn By	Figure No
August 2005	04-85	TRB	5

APPENDIX A

Acoustic Terminology

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 µPa, which is approximately the lowest sound pressure that can be detected by the human ear. For example:

If P = 20 µPa, then SPL = 0 dB
If P = 200 µPa, then SPL = 20 dB
If P = 2000 µPa, then SPL = 40 dB

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[1] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the

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[1] D.W. Robinson and R.S. Dadson, "A Re-Determination of the Equal-Loudness Relations for Pure Tones," *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226.

human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

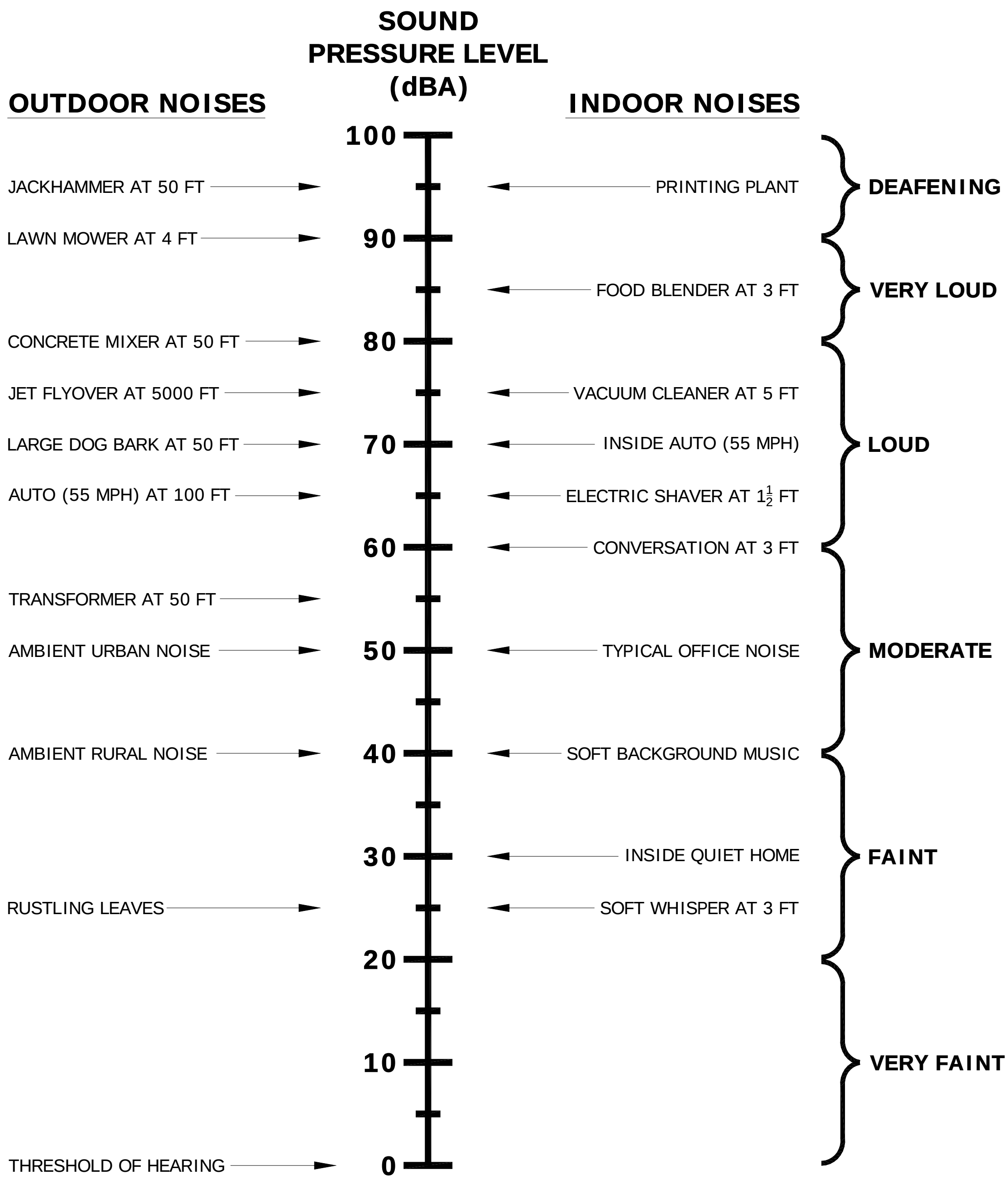

Figure A-1. Common Outdoor/Indoor Sound Levels

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

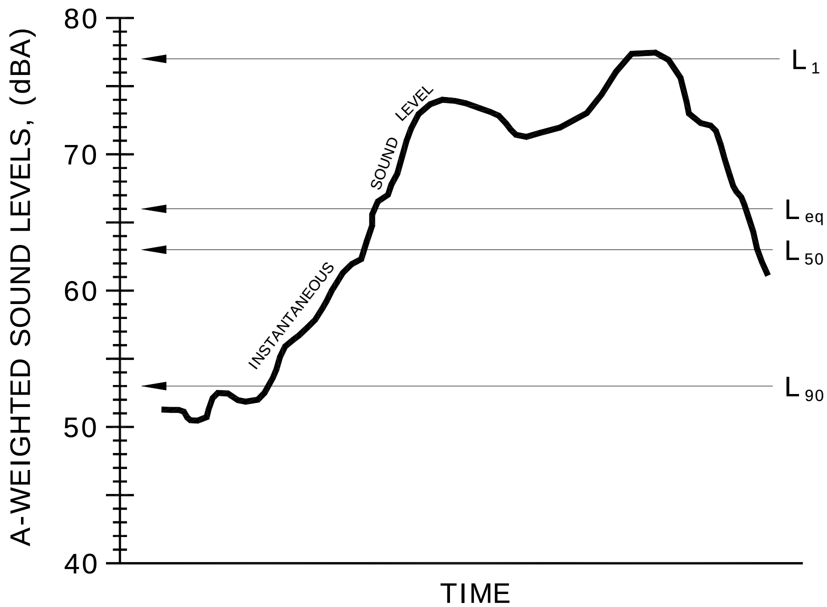

Figure A-2. Example Graph of Equivalent and Statistical Sound Levels

Statistical Sound Level

The sound levels of long-term noise producing activities such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels has been developed. It is known as the Exceedence Level, L_n. The L_n represents the sound level that is exceeded for n% of the measurement time period. For example, L_{10} = 60 dBA indicates that for the duration of the measurement period, the sound level exceeded 60 dBA 10% of the time. Typically, in noise regulations and standards, the specified time period is one hour. Commonly used Exceedence Levels include L_{01}, L_{10}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. A graphical description of the equivalent sound level is shown in Figure A-2.

Day-Night Equivalent Sound Level

The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 p.m. and 7 a.m. to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations.

Appendix N

AIR QUALITY STUDY

FOR THE PROPOSED

VILLAGE AT POIPU

POIPU, KAUAI, HAWAII

Prepared for:

Eric A. Knudsen Trust

September 2005

B.D. NEAL & ASSOCIATES

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FIGURES

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Table

1.0 SUMMARY

The Eric A Knudsen Trust is proposing to develop the Village at Poipu Project near Poipu, Kauai. The proposed project will consist of a total of 503 residential units and 12 acres of community parks. Development of the project is not expected to be completed and fully occupied until 2015. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are comparable to the national standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the Poipu area is very much affected by the topography of the island and its coastal situation. Winds are predominantly trade winds from the east northeast except for occasional periods when kona storms may generate strong winds from the south or when the trade winds are weak and landbreeze-seabreeze circulations may develop. Wind speeds average about 13 miles per hour providing relatively good ventilation much of the time. Temperatures in the area are generally very moderate with average daily temperatures ranging from about 68°F to 81°F.

Average annual rainfall in the Poipu area amounts to about 40 to 45 inches with summer months being the driest.

Although there is very little air quality data available from the Department of Health for the island of Kauai, the present air quality of the project area appears to be reasonably good. Based on the information available, it appears likely that all national air quality standards are currently being met, although occasional exceedances of the more stringent state standards for carbon monoxide may occur near congested roadway intersections.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, an air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are within both the state and the national ambient air quality standards. In the year 2015 without the project, carbon monoxide concentrations were predicted to remain largely unchanged despite an expected increase in traffic. This is because average motor vehicle emissions are expected to continue to decrease over time as older, more-polluting vehicles are retired. An exception to this would be the intersection of Koloa Road and Maluhia Road during the morning. A substantial increase in carbon monoxide was indicated at this location and time, but worst-case concentrations should still remain within standards. With the project in the year 2015, carbon monoxide concentrations were projected to remain almost unchanged compared to the without project case with only very slight increases at the intersections of Koloa Road at Poipu Road and Maluhia Road at Ala Kinoiki. Worst-case concentrations with the project should remain well within both national and state standards. Due to the small impact the project is expected to have, implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any impacts will likely be negligible. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts.

2.0 INTRODUCTION

The Eric A. Knudsen Trust is proposing to develop the Village at Poipu Project on 210 acres of vacant lands on the southern coast of the island of Kauai east of the existing Poipu Resort area (see Figure 1 for project location). The project would include approximately 503 single- and multi-family homes and over 30 acres of community parks and archeological preserves. Construction of the project is expected to commence during 2005 and be completed in phases over a 10-year period. Full development and occupancy is planned for sometime near 2015.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned.

Measures to mitigate project impacts are suggested where possible and appropriate.

3.0 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, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. 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 a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit. The U.S. Environmental Protection Agency (EPA) is currently working on a plan to phase out the national 1-hour ozone standard in favor of the new (and more stringent) 8-hour standard.

The Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards were challenged in federal court. A Supreme Court ruling was issued during February 2001, and at this time, it is expected that the new standards for particulate will be implemented in 2005. To date, the Hawaii Department of Health has not updated the state particulate standards. In September

2001, the state vacated the state 1-hour standard for ozone and an 8-hour standard was adopted.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affects 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, 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.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east of the islands. These tradewinds are one of the outstanding features of Kauai's climate along with equable temperatures from day to day and season to season and the marked variation in rainfall from the wet to the dry season and from place to place.

The nearest long-term wind data available for the project area are collected at the Lihue Airport located about 10 miles to the northeast of Poipu. These data are probably at least semi-representative of the project area. As indicated in Table 2, they indicate a mean annual wind speed of 12.8 mph and a northeast annual prevailing wind direction for this area of Kauai [1]. Monthly wind speeds and directions are similar to the annual averages. Winds from the south are infrequent occurring only a few days during the year and mostly in winter in association with kona storms.

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 stack sources. In Hawaii, the annual and daily variation of temperature depend 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. At nearby Lihue Airport, average annual daily minimum and maximum temperatures are 68°F and 81°F, respectively. The extreme minimum temperature on record is 50°F, and the extreme maximum is 90°F [1]. Temperatures at the project site are very similar.

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 often 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 the project area, stability classes 5 or 6 can be expected to occasionally occur, developing during clear, calm nighttime or early morning hours when temperature inversions form due to radiational cooling or to drainage flow from the mountainous interior of the island. 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 also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "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 Lihue area has a moderately wet climate. Normal annual rainfall for Lihue Airport is about 43 inches. Three-fourths of this total, on the average, falls during the wet season of October through April. Widespread rainstorms, which account for much of the precipitation, occur most frequently during this period. January is the wettest month, averaging over six inches [1]. Rainfall in the Poipu/Koloa area is similar.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from motor vehicles, industrial sources, agricultural operations and to a lesser extent by natural sources. Table 3 presents an air pollutant emission summary for the island of Kauai for calendar year 1993. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the particulate emissions on Kauai originate from area sources, such as the mineral/aggregate products industry and agriculture. Sulfur oxides are emitted almost exclusively by point sources, such as power plants and industrial boilers. Nitrogen oxides emissions emanate predominantly from area sources (mostly motor vehicle traffic), although industrial point sources also contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources.

Arterial roadways in the project area, such as Koloa Road, Maluhia Road, Poipu Road and Ala Kinoiki Road, presently carry moderate to heavy levels of vehicle traffic during peak traffic hours. Some of the emissions from motor vehicles using these roadways, primarily nitrogen oxides and carbon monoxide, will tend to be carried over portions the project site by the prevailing winds.

Sources of industrial air pollution are located at Port Allen, which is located about 8 miles to the west. These industrial sources emit sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide and other air pollutants. Prevailing winds from the east or northeast will carry these emissions away from the project area most of the time.

Until recently, air pollution in the project area originating from agricultural sources could mainly be attributed to sugar cane operations. Emissions from both the mill and much of the canefield operations in the area have now been eliminated with the closure of the Koloa Sugar Mill. Minor emissions of dust may occur from farming and ranching activities.

Natural sources of air pollution emissions that also could affect the project area but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the island of Hawaii.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state, but very little data is available for the island of Kauai. Table 4 shows annual summaries of air quality measurements for particulate (as PM-10) that were made at Lihue for the period 1999 through 2003. These are the only published and most recent air quality monitoring data that are currently available for the project area. Annual second-highest 24-hour PM-10 concentrations (which are regulated by state and federal standards) ranged from 24 to 36 $\mu g/m^3$ between 1999 and 2003. Average annual concentrations ranged from 14 to 18 $\mu g/m^3$. All values reported were within the state and national AAQS.

Although very little ambient air quality data is available to characterize existing conditions, due to the relatively small number of emission sources in the project area, it is likely that all ambient air quality standards are currently being met except perhaps for small areas around industrial sources or near traffic congested locations. Present worst-case concentrations of carbon monoxide due to traffic-related emissions occurring in the project area are estimated later in this study using computerized emissions and atmospheric dispersion models.

6.0 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 that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work.

The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] 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 at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at 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-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from 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.

Project construction activities will also likely obstruct the normal flow of traffic at times to such an extent that overall vehicular emissions in the project area will temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, which will begin to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 30 to 40 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

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 that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2004 with present conditions, (2) year 2015 without the project, and (3) year 2015 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project 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 queuing. For this study, three of the key intersections identified in the traffic study were selected for air quality analysis. These included the following intersections:

- Koloa Road at Poipu Road;
- Koloa Road at Maluhia Road;
- Maluhia Road at Ala Kinoiki.

The above intersections were selected for analysis based on existing and projected higher traffic volumes and, in some cases, lower levels-of-service that are expected to occur at these locations. The traffic impact report for the project [4] describes the projected future traffic conditions and laneage configurations of the study intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 43.6% light-duty gasoline-powered automobiles, 43.6% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.4% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

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 MOBILE6 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, all of the study intersections are unsignalized. In the future, in accordance with the traffic report, all study intersections were assumed to remain unsignalized.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings (where applicable). All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6 based on assumed free-flow vehicle speeds corresponding to the posted speed limits (25 to 45 mph depending on location).

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all three scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 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 the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. 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. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2004. Although increased traffic is expected to occur within the project area within the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 5 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 2004 with existing traffic, year 2015 without the project and year 2015 with the project. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2004) case was 3.8 mg/m^3. This was projected to occur during the afternoon peak traffic hour near the intersection of Koloa Road and Poipu Road. Concentrations at other locations and times studied were 3.7 mg/m^3 or lower. Predicted worst-case 1-hour concentrations at all locations studied for the 2004 scenario were within both the national AAQS of 40 mg/m^3 and the state standard of 10 mg/m^3.

In the year 2015 without the proposed project, the highest worst-case 1-hour concentration was predicted to occur during the morning at the intersection of Koloa Road and Maluhia Road. A value of 4.4 mg/m^3 was predicted to occur at this location and time. Peak-hour worst-case values at the other locations and times studied for the 2015 without project scenario ranged between 2.2 and 3.8 mg/m^3. Compared to the existing case, concentrations generally remained about the same except during the morning at the intersection of Koloa Road and Maluhia Road where a substantial increase was indicated. All projected worst-case concentrations for this scenario remained within the state and national standards.

Predicted 1-hour worst-case concentrations for the 2015 with project scenario were largely unchanged compared to the 2015 without project scenario. Similar to the without project case, a maximum concentration of 4.4 mg/m^3 was predicted to occur during the morning peak hour at the intersection of Koloa Road and Maluhia Road. Other concentrations ranged between 2.5 and 3.9 mg/m^3, well within the state and federal standards.

Predicted Worst-Case 8-Hour Concentrations

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 conditions are more variable (and hence more favorable for dispersion) 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 study based on modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [11] suggest that this factor may range between about 0.2 and 0.6 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 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 6. For the 2004 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the three locations studied ranged from 1.2 mg/m^3 at the Maluhia Road/Ala Kinoiki intersection to 1.9 mg/m^3 at the Koloa Road/Poipu Road intersection. The estimated worst-case concentrations for the existing case were within both the state standard of 5 mg/m^3 and the national limit of 10 mg/m^3.

For the year 2015 without project scenario, worst-case concentrations ranged between 1.2 and 2.2 mg/m^3, with the highest concentration occurring at Koloa Road and Maluhia Road. All predicted concentrations were within the standards.

For the 2015 with project scenario, worst-case concentrations remained nearly unchanged compared to the without project case, indicating minimal project impact. All predicted 8-hour concentrations for this scenario were within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both 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 extremely unlikely and 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. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The annual electrical demand of the project when fully developed is expected to reach approximately 3 million kilowatt-hours [12]. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities located on Kauai. 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 7 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at Kauai's power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 3. The estimated indirect emissions from project electrical demand amount to less than 1 percent of the present air pollution emissions occurring on Kauai.

7.3 Solid Waste Disposal

The maximum population of the project is not expected to exceed 1,574 residents [13]. It is estimated that solid waste from the project will amount to about 6.5 lbs per person per day [14]. Thus, solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 5 tons per day. Currently, all solid waste on the island is buried at a solid waste landfill. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the waste to the landfill and burying it. These emissions should be relatively minor.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

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. 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.

After the proposed project is completed, any long-term impacts on air quality in the project area due to emissions from project-related motor vehicle traffic should be small. Worst-case concentrations of carbon monoxide should remain within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of waste materials generated by the project will likely be negligible based on the magnitudes of the estimated emissions compared to the current island-wide emissions. To further moderate any impacts, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energysaving features into project design requirements. This might include the use of solar water heaters, water heater timers or possibly hot water on demand systems; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; movable, controlled openings for ventilation at opportune times; and possibly automated room occupancy sensors. Solid waste related air pollution could likely be reduced somewhat by the promotion of conservation and recycling programs within the proposed development.

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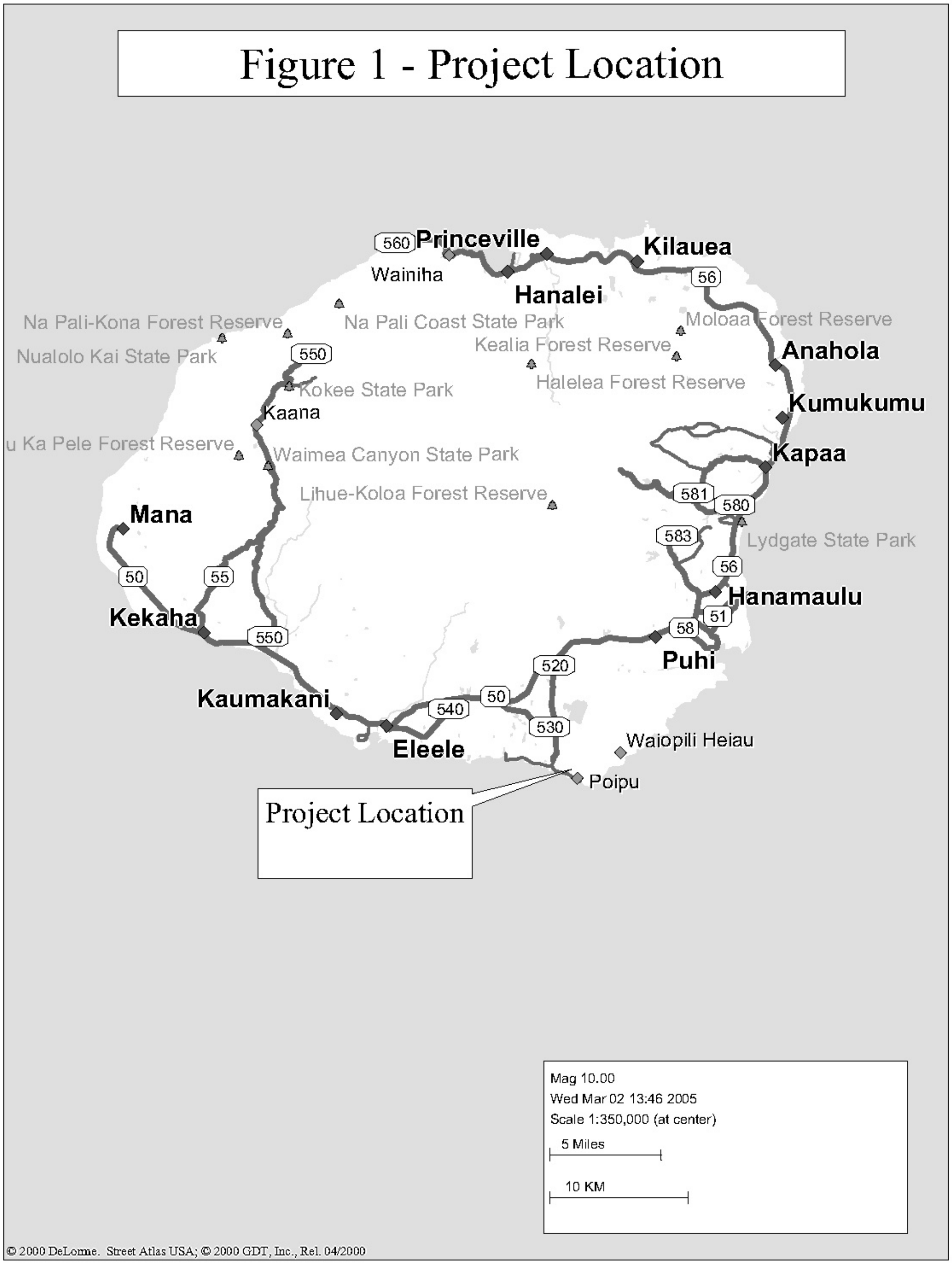
Figure 1 - Project Location
Princeville
Kilauea
Wainiha
Hanalei
Na Pali-Kona Forest Reserve
Na Pali Coast State Park
Moloaa Forest Reserve
Kealia Forest Reserve
Nualolo Kai State Park
Anahola
Kokee State Park
Halelea Forest Reserve
Kumukumu
Kaana
Kapaa
u Ka Pele Forest Reserve
Waimea Canyon State Park
Lihue-Koloa Forest Reserve
Mana
Lydgate State Park
Hanamaulu
Kekaha
Puhi
Kaumakani
Waiopili Heiau
Eleele
Poipu
Project Location
560
56
550
581
580
583
50
55
51
58
520
540
530
Mag 10.00
Wed Mar 02 13:46 2005
Scale 1:350,000 (at center)
5 Miles
10 KM
© 2000 DeLorme. Street Atlas USA; © 2000 GDT, Inc., Rel. 04/2000

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
Particulate Matter (<10 microns)	μg/m³	Annual 24 Hours	50[a] 150[b]	50[a] 150[b]	50 150[c]
Particulate Matter (<2.5 microns)	μg/m³	Annual 24 Hours	15[a] 65[d]	15[a] 65[d]	- -
Sulfur Dioxide	μg/m³	Annual 24 Hours 3 Hours	80 365[c] -	- - 1300[c]	80 365[c] 1300[c]
Nitrogen Dioxide	μg/m³	Annual	100	100	70
Carbon Monoxide	mg/m³	8 Hours 1 Hour	10[c] 40[c]	- -	5[c] 10[c]
Ozone	μg/m³	8 Hours 1 Hour	157[e] 235[f]	157[e] 235[f]	157[e] -
Lead	μg/m³	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	μg/m³	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.

[b] 99th percentile value averaged over three years.

[c] Not to be exceeded more than once per year.

[d] 98th percentile value averaged over three years.

[e] Three-year average of fourth-highest daily 8-hour maximum.

[f] Standard is attained when the expected number of exceedances is less than or equal to 1.

Table 2

MEAN WIND SPEED AND PREVAILING DIRECTION FOR LIHUE AIRPORT, KAUAI

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Speed (mph)	11.3	12.0	12.8	13.7	13.4	13.6	14.1	13.4	12.1	11.9	12.7	12.2	12.8
Direction	NE	ENE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Notes: Mean wind speeds are based on 32 years of data. Mean wind direction based on 20 years of data.

Source: "Local Climatological Data, Annual Summary With Comparative Data, Lihue, Hawaii, 1999", U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, National Climatic Center, Asheville, NC.

Table 3

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF KAUAI, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	614	4,817	5,431
Sulfur Oxides	703	nil	703
Nitrogen Oxides	4,072	7,054	11,126
Carbon Monoxide	2,315	11,974	14,289
Hydrocarbons	859	224	1,083

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 4

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST VILLAGE AT POIPU PROJECT

Parameter / Location	1999	2000	2001	2002	2003
Particulate (PM-10) / Lihue					
24-Hour Averaging Period:					
No. of Samples	54	50	57	56	61
Highest Concentration ($\mu g/m^3$)	35	39	31	27	31
2^{nd} Highest Concentration ($\mu g/m^3$)	26	36	29	24	27
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	17	18	17	14	16

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 1999 - 2003"

Table 5

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR VILLAGE AT POIPU PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario					
	2004/Present		2015/Without Project		2015/With Project	
	AM	PM	AM	PM	AM	PM
Koloa Road at Poipu Road	3.7	3.8	3.6	3.6	3.8	3.6
Koloa Road at Maluhia Road	2.1	3.7	4.4	3.8	4.4	3.9
Maluhia Road at Ala Kinoiki	1.7	2.3	2.2	2.5	2.6	2.5

Hawaii State AAQS: 10
National AAQS: 40

Table 6

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR VILLAGE AT POIPU PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	2004/Present	2015/Without Project	2015/With Project
Koloa Road at Poipu Road	1.9	1.8	1.9
Koloa Road at Maluhia Road	1.8	2.2	2.2
Maluhia Road at Ala Kinoiki	1.2	1.2	1.3

Hawaii State AAQS: 5
National AAQS: 10

Table 7

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM VILLAGE AT POIPU PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	0.1
Sulfur Dioxide	1
Carbon Monoxide	0.1
Volatile Organics	0.01
Nitrogen Oxides	0.4

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes electrical demand of 3 million kilowatt-hrs per year and low-sulfur oil used to generate power.

Appendix O

Market Study,
Economic Impact Analysis
and
Public Costs/Benefits Assessment
of the Proposed

VILLAGE AT POIPU

To be Located at
Poipu, Kauai, Hawaii

THE HALLSTROM GROUP INC.
REAL ESTATE
CONSULTANTS
& APPRAISERS

September 26, 2005

Mr. Stacey T.J. Wong
Eric A Knudsen Trust
3948 Ulu Alii Street
Kalaheo, Hawaii 96741

Market Study and Economic Impact Analysis of the Proposed Village at Poipu Poipu, Kauai, Hawaii

Dear Mr. Wong:

At your request, we have completed a defined-scope market study and economic assessment of the Village at Poipu master plan, a 202.8-acre residential community proposed for the elongated site stretching inland from Poipu Road, eight miles west of Lihue, Kauai, Hawaii. The long-planned project will include circa 350(1) single-family homes and multi-family units, as well as parks/open space, archeological preserves, landscaped parkways and pedestrian/bike paths.

The subject property, identified on State of Hawaii Tax Maps as Fourth Division Tax Map Key 2-8-14, Parcels 1, 2, 3, 4, 19 and 37, is a level to gently sloping site extending mauka from Poipu Road along the easterly frontage of Hapa Road.

The focus of our assignment is embodied in seven tasks:

1. To quantify the demand for resort/residential inventory (single-family homes and multi-family units) in the subject area and the competitive Kauai market using demographic, economic and other analytical techniques.

2. To identify the existing inventory of single and multi-family product in the effective market area, and their marketing and absorption histories.

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(1) There are 350 base dwelling units proposed for the master planning area. Up to 153 "Additional Dwelling Units", second living units for extended family or rentals, would be allowed on some of the subdivided single-family residential lots. Our study specifically focuses on the 350 base units, as the construction of the majority of the ADU's will be the decision of the eventual homeowners and not the Knudsen Trust. Where appropriate, we have included brief comments on the potential impacts of these ADU's, specifically the benefits to the Kauai housing inventory.

3. To identify current and proposed competitive inventory additions, in regard to timing, likelihood of actualization, and other relevant traits.

4. To assess the appropriateness of the subject holding for the proposed use and ascertain whether it has sufficient attributes to obtain a competitive market share.

5. To estimate the speed of absorption for the units in the subject project.

6. To estimate the direct and indirect, on and off-site benefits flowing to the local economy as a result of undertaking the subject development, including job and wage creation, business, operations and profits, and owner/guest discretionary expenditures.

7. To quantify the impact of the project on the public purse over time in regards to revenues generated (real property, income, excise and accommodations taxes) and costs of providing governmental services.

The function of our assignment was to provide market data, analysis of market supply/demand factors, and an informed opinion of the anticipated level of market success the subject inventory can expect to achieve, for use in the entitlement petitioning process and other land use regulatory submittals.

The pertinent results from our study are contained in the following summary report, focusing on tabular presentation with brief narrative conclusions.

In completing this assignment, we visited the subject property, environs, and competitive projects in the study area; interviewed knowledgeable developers, brokers and other parties regarding current sales and market conditions; utilized published and on-line databases; reviewed governmental land use designations, entitlements and policies in the region; and, identified proposed competitive developments for each subject use type and their attributes.

This study was prepared for The Knudsen Trust and PBR Hawaii, with Stacey Wong and Kimi Yuen, respective representatives, being the primary client contacts. The purpose of this assignment is to provide market analysis and conclusions regarding the proposed subject development for use in land use entitlement petitions for the property, and for internal planning purposes. The effective date of the study is April 1, 2005.

All conclusions presented herein are subject to the identified limiting conditions, assumptions and certifications of The Hallstrom Group, Inc., in addition to any others set forth in the text or tables. All work has been completed in conformance with the Code of Professional Ethics and Standards of Professional Appraisal Practice of the Appraisal Institute, and the Uniform Standards of Professional Appraisal Practice (USPAP).

Based on our investigation and analysis we conclude:

- The resort/residential market is in a strong demand cycle throughout the state and in the Poipu/Koloa study area, with rapid absorption and escalating prices for the limited product available. The vacation community and near oceanfront sector is evidencing particular strength, with all competitive inventory in the primary region having been absorbed.

- An estimated 4,000-plus dwelling units will be required in the study area during the next two decades. Fewer than 3,000 units are currently proposed.

- The property is well-suited for the proposed development and the master plan will achieve market acceptance by providing high quality, centrally located, resort/residential purchase opportunities for residents and second-home and vacation unit buyers.

- Complete market absorption of the 216 single-family lots/homes will require an estimated 6.5 years from the commencement of presale offerings. The 134 multi-family units will require circa seven years to achieve complete sell-out.

- The construction of the Village at Poipu and its on-going operations will create some 1,737 "worker years" of employment on Kauai during the first decade of its construction and use, with wages of circa $77.9 million. On a stabilized basis, home and unit maintenance will support about 29 full-time equivalent on-site jobs and contribute to another 12 off-site, with total wages of $1.2 million annually.

- The average daily de facto population of the project is projected at 1,145 persons, including 595 full-time residents, with annual discretionary expenditures of $56.7 million per year. The project will infuse $173 million in development capital and $4.2 million in annual business operations into the Kauai economy.

- The State of Hawaii will receive $43.8 million in primary tax receipts during the first decade of subject development and operation, and a stabilized amount of $4.8 million annually. The county of Kauai will receive $10.0 million during the first ten years of the project, and $1.3 million per year thereafter. In no year does the state or county suffer a revenue shortfall (costs exceeding receipts) relative to the project.

The up to 153 Additional Dwelling Units will expand and enhance the benefits of the Village at Poipu to the regional community. Over an extended period, needed residential units, typically of more moderate cost and oriented toward natural growth and extended households, will be added to the area at a discreet level minimizing system stress and disruption. The secondary homes will create construction and maintenance employment, increased spending and taxes.

We appreciate the opportunity to be of service in regards to this holding. Please contact us if further detail or discussion in the matter covered herein is required.

Respectfully submitted,

THE HALLSTROM GROUP, INC

Jas E Hallstrom

James E. Hallstrom, Jr., MAI, CRE

/as

THE HALLSTROM GROUP INC.
REAL ESTATE
CONSULTANTS
& APPRAISERS

Market Study,
Economic Impact Analysis
and
Public Costs/Benefits Assessment
of the Proposed

VILLAGE AT POIPU

To be Located at

Poipu, Kauai, Hawaii

Prepared for

Mr. Stacey T.J. Wong
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April 2005

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ASSIGNMENT AND SUMMARY OF CONCLUSIONS

Assignment

The Village at Poipu will be a resort/residential development containing 216 single-family homes and 134 multi-family units located on 202.8 acres within the Poipu vacation community.

The master plan also provides for up to 153 "Additional Dwelling Units" (ADU) to be incorporated into the project over time. These secondary units will create needed housing opportunities for local residents. Most of these ADU's will be built by the eventual homeowners, but the Knudsen Trust may construct some.

The purpose of our assignment was to analyze the 350 base units of the proposed subject project in light of competitive, regional, prevailing and forecast economic/market conditions in order to answer five foundational study questions:

1. Is there sufficient market demand to absorb the 350 units of the Village at Poipu master plan during a reasonable exposure period given competing developments and statewide/regional economic trends?

2. From a market perspective, will the subject project be a favorable use of the site relative to governmental land planning objectives, accepted master plan design characteristics, and the area environs?

3. What will be the general/specific and direct/indirect economic impacts on Kauai resulting from the undertaking of the subject development through capital investments, jobs, wages, business revenues and profits, de facto population, and resident/guest discretionary expenditures?

4. What will be the impact on the state and county "public purse" from the project in regards to costs of services required versus increased tax/fee receipts?

These issues were addressed through a comprehensive research and inquiry process utilizing data from market investigation, governmental agencies, various Hawaii-based media, industry spokespersons/ sources, on-line databases, and published public and private documents.

The pertinent results of our assignment are highlighted in this narrative report. Our study findings are divided into seven chapters as follows:

Study Conclusions
The Subject Property and Proposed Development
Environs -- Kauai and the Poipu Vacation Community
The Poipu/Koloa Resort/Residential Market
Subject Site Appropriateness and Absorption Conclusions
Economic Impact Analysis
Public Cost/Benefit Assessment

For this analysis, we have been provided with Village at Poipu conceptual master plans, project descriptions, timetables and other analytical data prepared by the owner/developer and PBR Hawaii, Inc. Additional source information regarding the subject was taken from the files of our past studies regarding the subject holding.

Study Conclusions

Based on our inspection of the subject site, its environs and analysis of the historic and forecast Kauai/Poipu real estate market, we have reached the following conclusions about the proposed Village at Poipu project:

The Poipu/Koloa Resort/Residential Market

The subject study area housing sector has historically been dominated by resort/vacation-oriented multifamily units makai of Poipu Road, and resident-oriented single family subdivision in mauka Poipu and Koloa. However, the proportion of single family homes in the makai areas, as well as the number of full-time residents electing to live there, has increased during the past two decades. Conversely, the number of non-resident buyers in the mauka Poipu and Koloa areas has also increased.

Several major proposed projects (including the subject) will in-fill the gap between the makai resort-oriented and mauka resident-oriented subdivisions; completing the long-planned South Kauai urban use node. These developments are expected to attract a mix of the purchaser types that currently contribute to both segments.

Despite evident (if cyclical) demand, the study region has experienced subdued construction in recent years. Yet, it is viewed by government agencies and private interests as a focal urban growth area servicing larger populations of residents and visitors on the island over the coming decades.

Currently, the Poipu/Koloa housing market is in a moderately to strongly undersupplied condition. Development in the area has been limited since the 1980s, with very low vacancy rates, high market interest, and rapidly appreciating prices over the last several years. The outcome has been a dysfunctional local housing sector and stymied tourism expansion during the on-going upswing in the visitor industry.

Evident governmental policy is to alleviate the unit shortage by permitting urban development of centrally-located, vacant, feral or nominal agricultural lands at as rapid a pace as the infrastructure and community will bear. This objective has been embodied via redistricting and general planning efforts completed during the past decade.

Based on our analysis, the actualization of a healthy and stable housing market in the study area will require the construction of about 2,544 to 5,517 additional housing units in the Poipu/Koloa area by the Year 2025. The mid-point demand would be for 4,031 units, or more than twice the in-place inventory.

About 23.5 percent of the regional units required through 2025 should be priced below a current level of $300,000, which would be generally affordable to the "low" and "low-moderate" income groups; 18.5 percent of demand will have price limits between $300,000 and $500,000 (affordable to "moderate-gap group" and lower market categories); 18 percent of demand will be oriented towards homes having prices of $500,000 to $750,000 (moderate market pricing); and, 40 percent will seek properties having a price above $750,000.

The atypically high percentage of demand oriented towards the top of the market is a function of the disproportionate number of upper-income non-resident buyers in the region, and that the large amount of new development will have commensurately higher prices.

Virtually all of the subject inventory will be oriented towards the 58 percent of the purchasers seeking homes at the moderate to high market price levels (more than $500,000).

Based on our investigation, we estimate the potential supply of new housing in the study area over the next 21 years, assuming the projects move reasonably forward into subsequent phases, will be about 2,555 total units; with an outside chance of an additional 400 on the state holding abutting the subject property toward the end of the time frame.

Therefore, approved supply will fall short of projected demand by at least 1,000 housing units during the next two decades.

Currently in the study area resort/residential sector, sales volumes are well up, market times are way down, appreciation is meaningful, and realtors report exceptional interest levels. Due to the extremely limited inventory available for resale in the region, the number of sales has remained relatively static resulting in rapidly escalating per unit prices.

We uncovered no indicators in our research and interviews which demonstrated anything other than the subject area being in the midst of a significant up-cycle, with highly favorable mid to long-term demand/supply trends. We conclude our analyses provide strong market support for the proposed Village at Poipu project.

Subject Appropriateness and Absorption Estimates

The 202.8-acre interior subject parcel, an elongated holding fronting Poipu Road, is a highly appropriate and favorably competitive location for the proposed Village at Poipu mixed-use resort/residential project. We conclude the physical, functional, scope, and amenity characteristics of the property are desirable from a market perspective, and enhance the salability of the finished single-family lots/homes and condominium unit inventory.

Primary contributing factors to this conclusion include:

- The subject property is a natural urban in-fill site being surrounded on three sides by existing and approved residential development.

- Poipu is a comprehensive, moderate to upscale, vacation and residential community planned as a focal point of Kauai development over the coming decades.

- The majority of the holding has had state and/or county land use designations supporting the proposed use for many years.

- The parcel is of sufficient size, shape, access and terrain to support a competitive, leading-edge, resort/residential project.

We have quantified absorption rates using three techniques, all of which point to a reasonable sell-out period of circa seven years for the 350 subject units. Our annualized absorption conclusions are displayed on Table A.

The gross analysis method indicates there are insufficient competitive units apart from the subject to meet demand regardless of other factors. The residual method demonstrates that the proposed competing developments could all achieve a reasonable absorption level and there would still be remaining demand for the subject product. And the market shares method indicates the Village at Poipu units would be absorbed in a timely manner based on its competitive penetration in the market.

We have not estimated the absorption of the potential 153 ADU's which will be allowed in the subject community as part of the master plan. While the Knudsen Trust may elect to construct a minor portion of these units during project development, the finished homeowners in the designated neighborhoods would be responsible for eventual build-out. These ADU's will provide additional needed housing inventory; often of more affordable class and constructed during market up-cycles over an extended period.

Economic Impact of the Subject Development[2]

The project will generate some $173 million in direct, new capital investment and spending into the Kauai economy during an eight-year planning and construction period. This will create an estimated $24.2 million in profits for local contractors and suppliers. On a stabilized basis after completion, some 41 maintenance/renovation workers and other on- and off-site positions will earn $1.2 million in wages each year, and resident/guest users of the project will spend $56.7 million annually in the local market.

A total of 1,241 worker/years of direct on-site employment will be created during the 10-year construction and operation study timeframe,

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(2) All dollar amounts contained in this report are based on constant, uninflated 2005 dollars.

TABLE A

SUMMARY OF ABSORPTION ESTIMATES BY PRODUCT TYPE
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
Using Rounded Mid-Point Demand Estimates

Sales Year (1)	Single Family Inventory (Houses)	Multi-Family Inventory (Units)	Total Unit Absorption Annually	Total Unit Absorption Cumulatively
1	35	15	50	50
2	40	20	60	110
3	40	20	60	170
4	40	20	60	230
5	40	20	60	290
6	21	20	41	331
7		19	19	350
Totals	**216**	**134**	**350**	
Time Required	**6.5 Years**	**7.0 years**		**7.0 Years**

(1) Assumes first product is available for sale/closing in late 2007.

Source: The Hallstrom Group, Inc.

along with an additional 496 worker/years in associated and indirect off-site employment. The total wages paid during the initial decade of development and use will be $77.9 million, peaking in year 6 of the project.

The full-time resident population at the subject is estimated to reach 595 persons, with approximately 149 school-aged children. Second-home owners and guests are expected to add a daily average of 550 persons to the community, resulting in a de facto population of 1,145 persons for the project. The discretionary expenditures by these individuals are expected to reach $56.7 million annually at build-out. The total household income of full-time residents is forecast to reach a stabilized level of $35.8 million per year.

The expenditure of employee wages, business profits, and resident/guest discretionary funds into the Kauai market will enhance hundreds of additional off-site, secondary/indirect jobs on the island, and generate several million dollars in additional wages.

The total direct, local economic impact to Kauai (dollars flowing into the island market) is estimated to be $341.7 million during the initial decade construction and operation study period, and stabilize at $62.0 million annually thereafter. As these dollars move through the island market, they will have a multiplier effect increasing the economic impact of the Village at Poipu to Kauai during its first 10 years to some $683.3 million.

The construction and use of the 153 ADUs will create significant additional economic benefits. However, it will be proportionately less as ADUs are typically smaller than the "main" house and often are used by new or elderly households having more modest incomes.

Further, apart from some units which may be built by the developer during later construction phases, their addition to the inventory will be extended and gradual as to be discreet with limited discernable impacts given the size of the regional community. For this reason, we have not made specific economic impact or public costs/benefits (following) assessments regarding the ADU inventory.

Public Cost/Benefit of the Subject Development

The county of Kauai will receive $10.0 million in real property tax receipts from the project over the 10-year study projection period, and an estimated $1.3 million per year thereafter. The county government operating costs associated with serving the subject, using a per capita basis, will total $6.8 million for the initial decade timeframe, and be some $1.1 million on a stabilized basis. The county will enjoy a net revenue benefit (taxes less costs), totaling $3.2 million during the first 10 years of construction and use, and $280,000 each year after build-out.

The State of Hawaii will also show a positive net revenue benefit from the Village at Poipu. The total gross tax revenues during the 10-year modeling period will reach $43.8 million from income and gross excise taxes, and will stabilize at $4.8 million annually following build-out. State costs associated with the project on a per capita basis will be $26.9 million during the projection timeframe and $4.2 million per year subsequently. The state will experience a net profit of $17.0 million in the 10 years and a stabilized benefit of $280,000 annually after build-out.

In no year does either the county or the state suffer a revenue shortfall due to the subject project.

THE SUBJECT PROPERTY AND PROPOSED DEVELOPMENT

Land

The 202.8 acre subject tract is an irregularly-shaped, elongated holding stretching mauka (northerly) from Poipu Road in the easterly portion of the Poipu community, approximately eight miles west of Lihue. The property, identified on State of Hawaii Tax Maps as Fourth Division Tax Map Key 2-8-14, Parcels 1, 2, 3, 4, 19 and 37, runs from approximately 50 feet above sea level along Poipu Road, where it is at street grade, to circa the 200 foot elevation along its inland border (Hapa/Weliweli Road junction).

The site has a depth of some 4,000 lineal feet and varies in width from 1,700 feet along Poipu Road to 700 feet in the central/upper portion of the property. The slope is generally consistent, with the terrain being level to slightly undulating.

The property has a mix of land use designations. The State Land Use Map designates portions of the site as being within the Urban and Agricultural Districts. The County of Kauai General Plan identifies the property for residential uses, and the County zoning overlay includes R-4, R-6, R-10 and Open classifications. Upwards of 337 units and 206 additional dwelling units could be developed with the existing zoning.

Access to the holding from makai is currently available from Poipu Road, a two-laned macadam-surfaced street (with turn pockets) running generally parallel to and inland from the shoreline. It is the primary arterial in the vacation village. Weliweli Road, a two-lane macadam street which runs from Koloa to Poipu, forms the mauka boundary of the property and could provide inland access in concert with Hapa Road, which extends from Weliweli down the upper third of the property's westerly border. The Kiahuna Golf Course access road also runs along a lower portion the westerly boundary of the site for some 1,500 feet.

Overall, ocean and mountain views from the subject are limited by the gradual slope of the property, vegetation and nearby development. However, moderate to expansive panoramas are available from selected points.

The property is currently overgrown with grasses, trees and shrubs, although there is a vacant area near Poipu Road. There are several identified archaeologically-significant sites on the holding. Those deemed of import will be protected within preserves excluded from the proposed subdivision.

A variety of existing uses are located on adjacent properties in the makai area. Along the mauka frontage of Poipu Road westerly abutting the subject is the Poipu Shopping Village, at 41,239 gross leaseable square feet the largest retail complex in the study area, and the Kiahuna Tennis Club & Spa. Across Poipu Road is the 338-unit Kiahuna Plantation condominium resort complex.

The Weliweli Makai subdivision, an older, generally built-out 97-lot residential development, abuts the easterly/makai area of the subject. The Kiahuna master planned community abuts the westerly/makai and central areas of the property. At present, only the golf course, shopping center, tennis club and first resort/residential increment (180 units) of the 730 unit project have been constructed, but infrastructure emplacement and second phase development is now underway.

In the mauka areas of the subject, the abutting properties are currently vacant. The 66 acre State-owned property to the east has been long-proposed for residential development, and has general plan approvals, but has been on hold for more than a decade.

Proposed Development

The Village at Poipu will be a resort/residential subdivision containing a total of 350 dwelling units divided between single family lots/homes (216 residences) and multifamily projects (134 units). The project will also contain a series of parks, open spaces and archeological preserves spread throughout the community.

The development densities will vary to provide a more diverse product inventory. Single family subdivisions will utilize the existing zoning, offering home sites ranging upwards from 6,000 square feet. The multifamily component will have underlying R-10 zoning, allowing for up to 10 units per acre. Further, circa 153 "additional dwelling units" (ADUs) could potentially be included in the project in the mauka areas of the site.(3)

The project is intended to attract a broad spectrum of purchaser types, including mid to upper-income Kauai residents, in-migrating households, second home/vacation buyers, and investors; with emphasis on the first two categories.

A central roadway leading mauka from Poipu Road will extend the length of the development, completing Hapa Road to its upslope terminus at Weliweli Road. This primary project arterial will have secondary connections into abutting existing and future projects. For the most part, the residential components will be double-loaded off of this main street.

(3) While some of the ADU's might be built by the master developer, the large majority will likely be built as second living units on single-family residential zoned lots. Typically, they are used for extended families or rentals. As these units are generally hypothetical and dependent upon the eventual purchaser, they are not included in our study.

The more intensive sites (multifamily and R-6) will be located in the makai areas of the holding, adjacent to the Poipu Shopping Center and Kiahuna Tennis Club & Spa, with density gradually decreasing moving inland.

The limited and gradual makai slope of the site will not provide for general, expansive view panoramas, and further obstruction will result from subject and nearby development. However, there may be ocean and/or mountain scenes available from selected lots in the central and mauka areas of the project.

Overall, the proposed subject development embodies modern residential planning concepts and contains the fundamental characteristics necessary for its product to be competitive in the regional market.

ENVIRONS

The county of Kauai consists of the islands of Kauai and Niihau, the two northernmost major islands of the Hawaiian chain. Kauai is the only island of economic significance. Niihau is privately owned and under the administrative jurisdiction of Kauai County, but only has a marginally productive agricultural base. Kauai is the third largest but least populated of Hawaii's four counties with a resident population of 58,463, estimated as of April 1, 2000, representing 4.82 percent of the total state population. The land area of Kauai is 549 square miles; and of Niihau, 70 square miles. Beautiful bays, many canyons, and spectacular scenery combined with lush tropical vegetation gives Kauai its nickname, the "Garden Isle."

MAP OF KAUAI

The subject property is situated within the Koloa Ahupua'a, stretching from the south boundaries of the Lihue-Koloa and Haupu Forest Reserve south to the Pacific Ocean. Ahupua'as were a traditional form of Hawaiian land holding providing the Hawaiian people with the necessities of life including fresh water, wildlife, fields to cultivate crops and food from the sea. Koloa is a rural southern community located approximately ten miles from Lihue. The town of Lihue is Kauai's largest community serving the economic role of providing administrative, distribution, and support service centers for the island. The county government is headquartered in Lihue, along with the county's deep draft Nawiliwili Harbor facility, a major distribution point for most goods coming in or out of the island.

Koloa, a small rural town located in the southwest region of Kauai, is Hawaii's oldest plantation town which started sugar production in the mid-1800s and was once the commercial and business hub of the island. Many of the sugar plantations that followed on the other islands duplicated the methods of operation from the Koloa plantation. Before sugar, Koloa was famous for its whaling, gathering of sandalwood and cultivation of various agricultural crops from coffee to potatoes. Today, Koloa is a quiet, rural town greatly influenced by the nearby coastal Poipu Resort community, situated approximately three miles to the south. Population in the Koloa Judicial District which includes the Koloa-Poipu-Kalaheo Planning District and the Port Allen and Eleele area increased steadily between 1990 and 2000 from 11,368 to 12,845. During this period the Koloa-Poipu district grew from 4,900 to 5,404 or at a rate of about one percent per annum, slightly below the pace of the County as a whole.

KOLOA-POIPU MAP

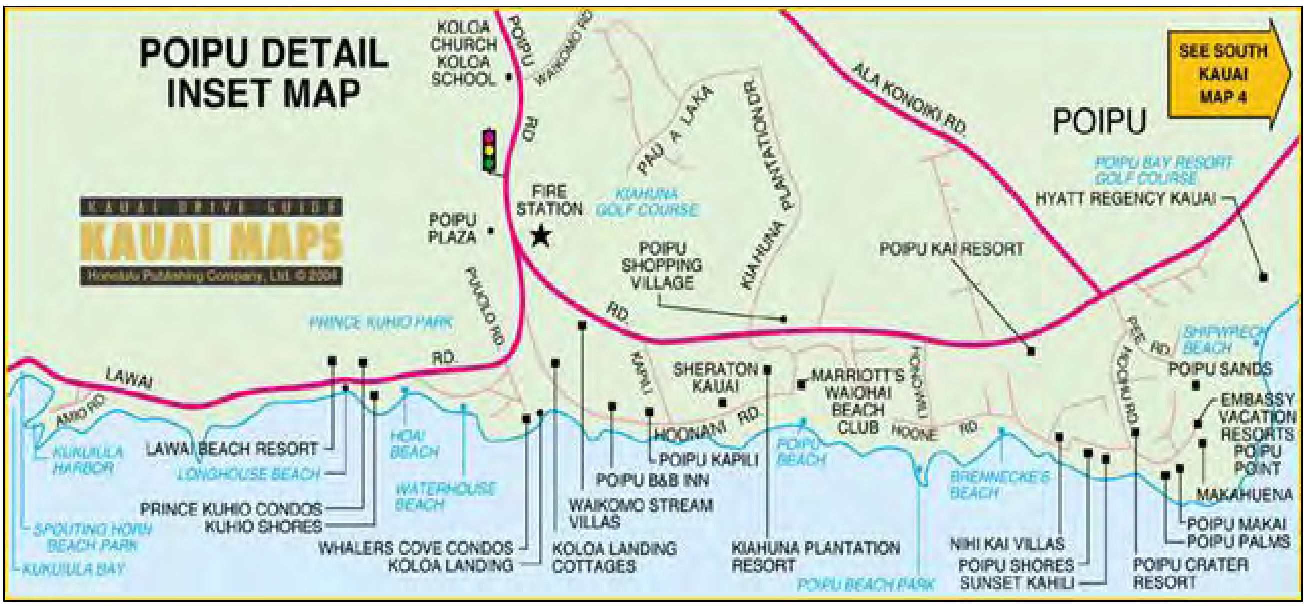
Many of the original buildings constructed in Koloa during the plantation era still remain. Some of these include the Kawamoto, Tao, Chang Fong, and Asahi Soda buildings. Each has its own historic and family background and are patronized by people from all parts the island and outer island visitors, as each offered their own special service. Koloa town has transcended into a tourist-oriented attraction depicting old Hawaii. Its buildings are occupied mostly by businesses selling tourist-oriented goods and services.

Poipu Resort is situated along the Koloa ahupua'as south boundary. One of Kauai's premier resort destinations, Poipu Resort suffered major damage from Hurricane Iniki in 1992. Prior to the hurricane Poipu enjoyed an inventory of over 1,500 hotel rooms including Poipu Beach Hotel, Sheraton Kauai Resort Hotel, Waiohai Hotel, and the 600-room Hyatt Regency Hotel, and an additional 775 units in several condominium/hotel and small hotel/beach rental projects. Following the aftermath of Hurricane Iniki, Poipu was left with only a limited number of rentable hotel rooms and condominium rental apartment lodging units. Since 1992 the Poipu area has been steadily rebuilding its visitor plant and resort facilities. The Hyatt Regency and Sheraton Kauai Resort (formerly managed by and recently purchased for $40 million dollars by Starwood Resorts), have been operational for several years, and many of Koloa's retail businesses and services have regained their economic foothold. In addition, the Marriott purchased the former 438-room Stouffer Waiohai Resort in late 1999 for demolition and redevelopment of the 237-unit Marriott Waiohai Beach Club timeshare facility.

The Poipu Shopping Village currently services the majority of Poipu's commercial needs. Located across Poipu Road from the Kiahuna Plantation multi-family residential development, this 41,239-square-foot retail center caters to a combination of tourists and local residents. With the increasing visitor count on Kauai, the shops and restaurants in the Poipu Shopping Village have benefited through steadily increasing occupancy levels. In recent years, the Poipu Shopping Village has been reporting occupancy of approximately 95 percent.

Major condominium projects in the Poipu area include the 30-unit Poipu Crater Resort, 73-unit Regency at Poipu Kai I, 60-unit Waikomo Stream Villas, 60-unit Poipu Kapili, 40-unit Poipu Shores, 35-unit Sunset Kahili, 78-unit Makahuena and recently completed 28-unit Regency at Poipu Kai II condominium. The 338-unit Kiahuna Plantation Resort, represents a master-planned 486-acre development. Recreational amenities servicing this residential resort include the 18-hole Kiahuna Golf Club championship golf course, golf club house and tennis club.

Poipu Kai is a master-planned 110-acre residential resort community stretching inland from the famous Brennecke Beach to the beautiful white sand beach at Keoneloa Bay. The project has a private park corridor stretching the entire length of the property. The basic infrastructure improvements including roads, water, sewer, electrical, drainage, and telephone have been completed. Four condominium projects totaling 240 units are in Poipu Kai; they include the 82-unit Kahala at Poipu Kai (Phase I); 72-unit Poipu Sands; 22-unit Makanui; and the 52-unit Manualoha I, and 12-unit Manualoha II condominiums. There are also 47 house lots in the Lanai Villa Makai Subdivision and 40 lots in the Bayview Subdivision. Major Poipu landmarks are shown on the following detailed map of the area.



MAP OF MAJOR POIPU LANDMARKS

In addition to the hotel and resort development previously discussed, several "pockets" of residential development lie within the boundaries of the subject's greater neighborhood. This area, essentially the coastal lands stretching from Keoneloa Bay (Shipwreck Beach) to Lawai Bay, is scattered with older near-shore subdivisions (just mauka of the coastal road) and new custom homes. These include the Spouting Horn Tract, and the Kula and Keawaloa tracts. Lying immediately mauka of Poipu Road is the Weliweli Houselots subdivision. The quality of the homes in Poipu range from old "plantation" style cottages to upscale oceanfront residences featuring modern designs and amenities.

Pending new residential product in the Poipu-Koloa market will include the circa 550 single- and multi-family residences on the remaining sites surrounding the Kiahuna Golf Club course; the proposed 325 unit Poipu Beach Villas multi-family development situated on the opposite side of Poipu Road from the golf course, and approximately 1,500+ single- and multi-family dwellings at Kukui'Ula, a long-range master-planned community encompassing approximately 1,045 acres. The Kukui'Ula acreage is west of the Poipu Resort destination and north of the numerous upscale single-family residences that frame the Lawai coastline. Envisioned as a predominantly residential community, Kukui'Ula will eventually feature a mixture of residential and resort amenity uses plus a small lodge weaving around an 18-hole Tom Weiskopf designed golf course. Supporting commercial facilities and a community park will be developed on lands adjacent to Poipu Road.

The first phase of the Koloa-Poipu bypass road, extending north from Poipu Road near the Hyatt Regency Hotel to Weliweli Road, was completed to alleviate traffic conditions in Koloa town, created primarily by the ongoing development of Poipu Resort. The second phase, which extends the roadway further north along the eastern side of the Waikomo residential area to Maluhia Road, bypassing Koloa town, opened August 16, 2001.

Primary access to Koloa is via the State's Kaumualii Highway, a two-lane thoroughfare connecting Lihue to a point just beyond the Pacific Missile Range Facility on Kauai's West Side. Other major collector roads extend throughout this region accessing various residential communities and supporting commercial centers.

Water to Koloa and Poipu is provided by the Koloa and Poipu interconnected County water systems. Approximately 20 percent of the Koloa system's capacity is uncommitted and storage systems are rated adequate. The Poipu system has a source capacity of 3.5 million gallons per day (mgd) with about 15 percent available to accommodate new development.

County wastewater service is not available in the Kalaheo-Koloa-Poipu Planning District. Resort developments in the Poipu area are serviced by privately-owned treatment plants. Private residences and non-resort commercial buildings use individual wastewater systems such as cesspools and septic tanks.

Poipu, due to its sunny climate continues to attract an increasing segment of Kauai's tourism base. Assuming continuation of the current stable economic climate, this region's long term visitor appeal continues to be favorable.

THE POIPU RESORT/RESIDENTIAL MARKET

Our analysis of the Poipu/Koloa resort/residential market is divided between two perspectives:

- Macro Analysis -- Assessing the overall, long-term demand and supply trends in the competitive sector; and

- Micro Analysis -- Focusing on the current demand/supply levels in the subject segment.

The study opens with a brief overview of resort/residential development in the study area followed by an analysis quantifying the demand for additional housing units in Poipu/Koloa based on population, tourism, and real estate trends. Existing and proposed inventory supply is then identified in regards to number of units, development timing and product type. To the extent mid to long-term demand exceeds supply in the study area, the general (or macro) climate for the proposed subject development is favorable.

The second part of the study reviews current market activity in the region, including the status of the market cycle, availability of inventory, pricing and appreciation levels, and exposure time required for sale. This aids in determining whether sufficient near to mid-term demand exists relative to potential supply to support a new project and successfully absorb the initial phases. If the market cycle is up, rapidly absorbing available units, and inventory is limited, the micro conditions are favorable for the Village at Poipu.

The Poipu/Koloa housing sector has historically been dominated by resort/vacation-oriented multifamily units makai of Poipu Road, and resident-oriented single family subdivision in mauka Poipu and Koloa. However, the proportion of single family homes in the makai areas, as well as the number of full-time residents electing to live there, has increased during the past two decades. Conversely, the number of non-resident buyers in the mauka Poipu and Koloa areas has also increased.

Several major proposed projects (including the subject) will in-fill the gap between the makai resort-oriented and mauka resident-oriented developments; completing the long-planned South Kauai urban use node. These developments are expected to attract a mix of the purchaser types that currently contribute to both segments.

Despite evident (if cyclical) demand, the study region has experienced subdued development in recent years. However, it is viewed by government agencies and private interests as a focal urban growth area servicing larger populations of residents and visitors on the island over the coming decades resulting from:

- Poipu being the primary vacation destination on the island;
- A scarcity of alternative, entitled acceptable development areas;
- Proximity to good, services, and support uses in South and Central Kauai;
- Ease of access to employment centers and other areas of the island; and
- A desirable warm, dry leeward climate.

Over the past two decades, the supply of housing units in Poipu/Koloa has failed to keep pace with either resident or resort demand segments; the limited development on the island being focused in the Central Kauai urban corridor (Lihue to Kapaa) and Princeville.

Macro Analysis

Projecting the probable mid to long-term regional demand for the subject resort/residential units is a three-step process:

1. <u>Quantification of Poipu/Koloa Housing Unit Demand</u> -- Estimating the need for additional housing units in the study area based on population, demographic, vacancy and income characteristics.

2. Identification of Current and Proposed Projects -- Overview of recent/in-sales and proposed/potential residential development in the study area units in regards to unit types and sales activity.

3. Indicated Conclusions -- Correlation of quantified market demand and supply indicators.

We have assumed the subject units would be priced at general market levels consistent with other new housing product in the study area and attract a typical spectrum of buyers. It is our understanding the developer will meet affordable housing criteria established/negotiated with State and County planning agencies. To the extent any affordably-priced units are built on-site, the expected rate of absorption would increase given the island-wide shortage of such product.

For analytical purposes, a resort/residential housing unit is defined as an individually-owned, non-commercial standard dwelling capable of supporting extended habitation. It is primarily intended for long-term use by a given household (resident or second home) and guests, as opposed to constantly changing short-term transient accommodations. It differs from a "standard" residential unit only in that it has distinct second/vacation home potentials.

Quantification of Poipu/Koloa Housing Unit Demand

We have projected the demand for resort/residential units in the Poipu/Koloa Community Planning area using standardized formulae employing population forecasts, household size trends, and other market-based factors as follows:

RP/AHS = TRUR X (1 + (VA + NRPA)) = TMUD

Where:

RP is the Resident Population
AHS is the Average Household Size
TRUR is the Total Resident Units Required
VA is a Vacancy Allowance
NRPA is a Non-Resident Purchaser Allowance
TMUD is a Total Market Unit Demand

Each of the variables in the formula is based on historic statistics compiled by the Federal Home Loan Bank, U.S. Census Bureau, State of Hawaii DBEDT, other recognized governmental sources, and researched market data.

These past and current indicators were translated into estimates based on temperate trending interpretations. Our emphasis was on letting the data "speak for itself" through our projections, as opposed to making large-scale adjustments for subjectively anticipated lifestyle or market evolutions.

In this regard, our forecasts are representative of moderate future housing requirements, and could be understated if some movements continue as strongly as in recent years; such as the trend towards smaller household sizes and an increasing influx of non-resident purchasers into the market.

The "Total Market Unit Demand" conclusions resulting from equation application are intended to quantify the total number of resort/residential housing units which will be needed in the study region over a 21-year projection period (2005 through 2025) in order to manifest a reasonably stable market with all purchaser/tenant demand segments served.

Currently, the Poipu/Koloa housing market is in a moderately to strongly undersupplied condition. Development in the area has been limited since the 1980s, with very low vacancy rates, high market interest, and rapidly appreciating prices over the last several years. The outcome has been a dysfunctional local housing sector and stymied tourism expansion during the on-going upswing in the visitor industry.

Evident governmental policy is to alleviate the unit shortage by permitting urban development of centrally-located, vacant, feral or nominal agricultural lands at as rapid a pace as the infrastructure and community will bear. This objective has been embodied via redistricting and general planning efforts completed during the past decade.

The factors comprising our housing demand equation can be summarized as follows:

> Resident Population (RP) -- This variable utilizes population and distribution forecasts made by the State, County and ourselves for the island and/or study area. The DBEDT 2030

series of forecasts calls for Kauai's resident population to increase by one-third and 21,900 persons over the coming quarter of a century (1.27 percent compounded annual growth rate), with the daily tourist population to be up by more than half and 9,450 visitors (1.86 percent annually).

The County of Kauai General Plan resident projections through 2020 closely mirror the State figures, both use a 1.2 percent annual growth rate and forecast a population of 74,000-plus by that time. However, the County is more bullish on tourism, projecting a 2.53 percent annual growth in the average number of daily visitors and gains of more than three-quarters by 2020.

The General Plan also indicates that Poipu/Koloa will be a focal point of the development necessary to serve the increasing populations of the island.

We forecast that of the 17,000-plus new residents forecast for the island by 2025, during the two decade scope of our model, from 4,800 (28 percent) to 7,700 (45 percent) will be housed in the study area. Given the scarcity of zoned lands elsewhere on Kauai, and community opposition to urban encroachment, these proportions are likely conservative.

Average Household Size (AHS) -- This factor was calculated using the data as provided by the above-cited sources and census figures. Extrapolating the 2000 US census indicators for the study area, we have estimated the current AHS in the study area is at 2.47 persons. This is at the middle to lower-end of the range for Kauai regions, a function of the proportion of multifamily units (versus higher occupancy single family homes) and the number of mainland retirees who re-locate there .

Most Hawaii-oriented sociologists contend the movement to smaller household sizes will continue into the future; forecasting longer life-spans, the influx of single persons attracted to the climate and employment opportunities, and the tendency towards fewer children. However, we believe the AHS of the study area will not decline during the model time frame, but will hold steady or increase as more, larger single family homes are built attracting growing Kauai households.

We project the average household size level in the study area will stabilize by the Year 2025 at between the current level of 2.47 and 2.65 persons, still slightly below most island locales.

Total Resident Units Required (TRUR) -- This figure is arrived at by dividing the subject area resident population (RP) by the average household size (AHS). It is indicative of the minimum number of residences which would be required to meet basic market needs, assuming there were no vacant units, none uninhabitable due to on-going repair or deleterious conditions, and none occupied by non-resident persons.

For a market to be considered stable (and nominally operative) with acceptable appreciation rates and quality lifestyle opportunities, allowances for such factors must be made.

Vacancy Allowance (VA) – Governmental agencies are on record during the past 20 years calling the state one of the tightest residential markets in the nation, expressing fears of a deteriorating economy and community structure unless major steps are taken over the long-term to address the shortage. The undersupply condition is a primary reason Kauai housing prices are on average among the highest of any locale in the country.

According to HUD, the Urban Institute, and other sources, a "healthy" market has a minimum vacancy level of five to six-plus percent of the total number of units in the inventory. This allows for uninhabitable units, units under repair, seasonal fluctuations, a transitional housing margin, a degree of mobility potential, and the ability to service periodic unanticipated population increases. A "slack" in unit occupancy also serves as a margin to cushion against hyper-appreciation during strong demand periods.

Given the history of the Kauai housing market and its inability to keep an acceptable vacancy pool available, we believe it will be exceptionally difficult for the desirable vacancy allowance of more than five percent to be achieved on the island during the foreseeable future.

In our demand formula, we have tested vacancy rate allowances of four and five percent of the Total Resident Units Required figure.

Non-Resident Purchaser Allowance (NRPA) -- While many non-resident purchasers of housing units seek to rent them to residents in an effort to minimize debt service obligations, an increasing number are buying Hawaii residential units for personal (family and friends) second-home use, business reasons, or to place in rental pools for transient, non-resident "visitors."

These units are not available to meet resident housing demands and are effectively withdrawn from the inventory pool. An allowance must be made for these residences in the general community, which are not to be confused with those specifically intended for tourist-oriented transient rentals (i.e., within a condominium/hotel project in a resort-classified area).

On the neighbor islands and in Waikiki, there are many units in complexes or subdivisions designed for general residential use, which often sit vacant the vast majority of the time.

Our research indicates most projects in neighbor island vacation (non-resort) communities such as Kailua-Kona, Kihei and Poipu have upwards of 30 percent non-resident, investor-owned units/homes. In some in-resort developments (particularly Hualalai, Mauna Kea Beach, Mauna Lani, and Kapalua), up to 90-plus percent of selected complexes are so held.

The impact of these buyers on the market must be taken into consideration when projecting a region's housing unit needs, given the widespread interest in Hawaii real estate and typically greater financial resources of non-resident buyers. Failure to adequately account for their demand places extreme stress on island towns.

In Poipu, which is Kauai's primary vacation community, the proportion of non-resident purchasers is widely acknowledged, by some estimates comprising more than half the Poipu/Koloa study area market. The issue is even addressed in the General Plan, which states, "(In) Koloa-Poipu-Kaleheo several of the multi-family projects may have a combination of resident-occupied and transient vacation rentals. For these projects, it was assumed that 35 percent of the units would be used by residents (65 percent by visitors)."

The condition is further exacerbated by the scarcity of vacant resort-zoned properties in the area available to capture more of the second-home segment.

We have therefore utilized a NRPA of 25 percent to 50 percent of quantified resident user demand.

Total Market Unit Demand (TMUD) -- The solution to our demand formula is quantified by adding the Vacancy Allowance (VA) and Non-Resident Purchaser Allowance (NRPA) to the Total Resident Units Required (TRUR) figure. This is the total number of units which will be needed in the study region in order to meet all reasonable market demands.

The application of the housing demand formula to the subject region using our conservative/minimum and optimistic/maximum forecasts are shown on Table 1. Extrapolation of 2000 census figures indicates there are some 1,400 existing housing units in the study area.

Based on our analysis, the actualization of a healthy and stable housing market in the study area will require the construction of about 2,544 to 5,517 additional housing units in the Poipu/Koloa area by the Year 2025. The mid-point demand would be for 4,031 units, or more than twice the in-place inventory.

Conversion of this estimate of gross demand into pricing equivalents was completed using available data from the U.S. Census, Kauai Board of Realtors, and the U.S. Dept. of HUD.

Table 2 illustrates the striation of Poipu/Koloa regional housing requirements through 2025 into probable percentile demand by sales prices at current dollar levels. The figures correlate both historic actual buying trends and theoretical "affordability" quotients derived using government pricing criteria.

Table 3 displays the calculations of housing price affordability for Kauai residents based on HUD/State/County and conventional financing guidelines.

TABLE 1

QUANTIFICATION OF HOUSING UNIT DEMAND FOR THE POIPU-KOLOA AREA 2005 TO 2025
Market Study of the Proposed Village at Poipu Project
Poipu, Kauai, Hawaii

	2005	2010	2015	2020	2025	Additional Units Required by 2025 (1)
Scenario One: Conservative/Minimum Projections						
Resident Population (2)	3,319	4,148	5,185	6,482	8,102	
Average Household Size	2.47	2.50	2.55	2.60	2.65	
Total Resident Units Required	1,344	1,659	2,034	2,493	3,057	
Vacancy Allowance (4% of resident unit demand)	54	66	81	100	122	
Non-Resident Purchaser Allowance (25% of resident unit demand)	336	415	508	623	764	
TOTAL MARKET UNIT DEMAND	**1,733**	**2,141**	**2,623**	**3,216**	**3,944**	**2,544**
Scenario Two: Optimistic/Maximum Projections						
Resident Population (3)	3,319	4,480	6,048	8,165	11,023	
Average Household Size	2.47	2.47	2.47	2.47	2.47	
Total Resident Units Required	1,344	1,814	2,449	3,306	4,463	
Vacancy Allowance (5% of resident unit demand)	67	91	122	165	223	
Non-Resident Purchaser Allowance (50% of resident unit demand)	672	907	1,224	1,653	2,231	
TOTAL MARKET UNIT DEMAND	**2,083**	**2,811**	**3,796**	**5,124**	**6,917**	**5,517**

CONCLUDED HOUSING UNIT DEMAND RANGE

	Existing	2005-2010	2011-2015	2016-2020	2021-2025	Totals
MINIMUM DEMAND						
Periodic	333	407	483	593	728	2,544
Cumulative	333	741	1,223	1,816	2,544	
Average Annual Demand (4)		123	97	119	146	
MAXIMUM DEMAND						
Periodic	683	729	984	1,328	1,793	5,517
Cumulative	683	1,411	2,396	3,724	5,517	
Average Annual Demand (4)		235	197	266	359	
MID-POINT DEMAND						
Periodic	508	568	733	961	1,261	4,031
Cumulative	508	1,076	1,809	2,770	4,031	
Average Annual Demand (4)		179	147	192	252	

(1) There are an estimated 1,400 housing units in the Poipu-Koloa market area as of the beginning of 2005, based on extrapolations from 2000 Census data
(2) Population growth equivalent to 2.83 percent compounded annually during projection period.
(3) Population growth equivalent to 3.71 percent compounded annually during projection period.
(4) Existing (or latent) demand is assumed absorbed during first projection period (2005-2010

Source: 2000 US Census, Kauai County General Plan, Various. and The Hallstrom Group, Inc

TABLE 2

STRIATED PROJECTIONS OF HOUSING UNIT DEMAND
BY SELLING PRICE IN POIPU/KOLOA 2005 TO 2025
Market Study of the Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
Demand Quantified as a Function of Income and Market Factors

Period	Periodic Demand (1) 2005 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	Total Demand 2005-2025
1. Using Minimum Demand Forecasts					
Less Than $300,000 (1)	**185**	**116**	**137**	**161**	**598**
Percent of Total Demand	25.00%	24.00%	23.00%	22.00%	23.48%
$300,000 to $500,000 (2)	**148**	**92**	**107**	**124**	**471**
Percent of Total Demand	20.00%	19.00%	18.00%	17.00%	18.48%
$500,000 to $750,000	**133**	**87**	**107**	**131**	**459**
Percent of Total Demand	18.00%	18.00%	18.00%	18.00%	18.00%
$750,000 to $1,000,000 (3)	**125**	**87**	**113**	**146**	**472**
Percent of Total Demand	17.00%	18.00%	19.00%	20.00%	18.52%
Over $1,000,000 (3)	**148**	**102**	**131**	**168**	**548**
Percent of Total Demand	20.00%	21.00%	22.00%	23.00%	21.52%
Total Market Demand	**738**	**485**	**595**	**730**	**2,548**
	100.00%	100.00%	100.00%	100.00%	100.00%
2. Using Maximum Demand Forecasts					
Less Than $300,000 (1)	**353**	**236**	**306**	**395**	**1,290**
Percent of Total Demand	25.00%	24.00%	23.00%	22.00%	23.36%
$300,000 to $500,000 (2)	**282**	**187**	**239**	**305**	**1,014**
Percent of Total Demand	20.00%	19.00%	18.00%	17.00%	18.36%
$500,000 to $750,000	**254**	**177**	**239**	**323**	**994**
Percent of Total Demand	18.00%	18.00%	18.00%	18.00%	18.00%
$750,000 to $1,000,000 (3)	**240**	**177**	**253**	**359**	**1,029**
Percent of Total Demand	17.00%	18.00%	19.00%	20.00%	18.64%
Over $1,000,000 (3)	**282**	**207**	**293**	**413**	**1,194**
Percent of Total Demand	20.00%	21.00%	22.00%	23.00%	21.64%
Total Market Demand	**1,410**	**985**	**1,330**	**1,795**	**5,520**
	100.00%	100.00%	100.00%	100.00%	100.00%

Notes:

A. The median household income for Kauai for 2005 is estimated at $63,300 based on extrapolation of most recent estimates of $56,300 in 2002 made by HUD and Kauai County, with compounded growth rate of 4.0% annually (a conservative figure).

B. The median sales price for single family homes on Kauai reached $672,000 in February 2005, up 48% from 2004. The median sales price for condominium units was $431,360, down 1% from the prior year.

(1) Low Income Households (making 80% or less than Countywide median household income) and Low-Moderate Income Households (making 80% to 100% of County median) would fall into this price category.
(2) This price category encompasses the "affordability" range for households earning from 100% to 140% of county median (the Moderate to Gap Group classification).
(3) Virtually all second-home/non-resident demand would fall into these categories and particularly dominate the "over $1,000,000" segment.

Source: Various and The Hallstrom Group, Inc.

TABLE 3

ESTIMATE OF HOUSING PRICE AFFORDABILITY FOR KAUAI RESIDENTS
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii

1. Based on General HUD/State/Kauai County Criteria

Grouping	**Low Income**	**Low-Moderate Income**	**Moderate-Gap Group Income**
Household Income as a Percent of County Median	**80% or less**	**80% to 100%**	**100% to 140%**
Gross Household Monthly Income	$4,220	$5,275	$7,385
Maximum Allowable Housing Expense (1)	$1,393	$1,741	$2,437
Less Tax and Insurance Reserve	($150)	($175)	($200)
Less Mortgage Insurance Payment	($50)	($75)	($100)
Net Amount Available for Debt Service	$1,193	$1,491	$2,137
Maximum Mortgage Amount (2)	$208,065	$260,037	$372,703
Down payment at 5% of Sales Price	$10,951	$13,686	$19,616
Total Affordable Purchase Price	**$219,016**	**$273,723**	**$392,319**

2. Based on Conventional Financing Criteria

Grouping	**Low Income**	**Low-Moderate Income**	**Moderate-Gap Group Income**
Gross Household Monthly Income	$4,220	$5,275	$7,385
Maximum Allowable Housing Expense (3)	$1,182	$1,477	$2,068
Maximum Mortgage Amount (4)	$206,147	$257,596	$360,669
Down payment at 20% of Sales Price (5)	$51,537	$64,399	$90,167
Total Affordable Purchase Price	**$257,684**	**$321,995**	**$450,836**

(1) Based on standard governmental affordability criteria at 33%.
(2) Assuming 5.5% annual interest and 30 year mortgage..
(3) Conventional financing with maximum monthly mortgage payment at 28% of gross income. No reserves of mortgage insurance required.
(4) Assuming 5.5% annual interest and 30 year mortgage.
(5) Conventional financing standard.

Source: HUD, State of Hawaii, Kauai County and The Hallstrom Group, Inc.

Using the governmental criteria, households in the "Low Income" grouping, earning 80 percent or less of the island median income, can afford a sales price, or rental equivalent, of $219,000 (rounded) or less. "Low to Moderate Income" households, earning 80 to 120 percent of median income, can afford home prices up to $274,000. And, "Moderate-Gap Group (or "low market") Income" households can afford prices up to $392,000. Above this level, prices are considered "market".

Using conventional financing criteria, the affordable housing prices for the respective groups increase by about 15 to 18 percent.

Inherently, a large portion of the demand is generated by lower- to middle-income groups who can have difficulty competing in the high-priced Kauai marketplace. Upper-middle and above income households have more meaningful purchase alternatives.

About 23.5 percent of the regional units required through 2025 should be priced below a current level of $300,000, which would be generally affordable to the "low" and "low-moderate" income groups; 18.5 percent of demand will have price limits between $300,000 and $500,000 (affordable to "moderate-gap group" and lower market categories); 18 percent of demand will be oriented towards homes having prices of $500,000 to $750,000 (moderate market pricing); and, 40 percent will seek properties having a price above $750,000.

The atypically high percentage of demand oriented towards the top of the market is a function of the disproportionate number of upper-income non-resident buyers in the region, and that the large amount of new development will have commensurately higher prices.

Virtually all of the subject inventory will be oriented towards the 58 percent of the purchasers seeking homes at the moderate to high market price levels (more than $500,000).

Given land, subdivision and construction costs, it would be difficult to meet anticipated regional housing demands solely through single-family development. Further, a significant portion of the non-resident and investor buyer segments prefer condominium units. Multi-family projects <u>must</u> be more vigorously pursued on interior non-resort sites during the next two decades in order to keep the Poipu/Koloa housing sector in balance.

Of the 263 units added to the study area housing inventory during the past 20 years (1984 onward), 62 percent was comprised of single-family homes (finished houses or lots) and 38 percent were multi-family units. However, the majority of multi-family units have historically been built in the makai resort area with few in the lands mauka of Poipu Road.

As shown on Table 4, we forecast that multi-family units will increase slightly in overall proportion (but meaningfully from a locational perspective) to single-family homes in new projects over the next 21 years owing to increasing urban densification pressures and non-resident demands, moving upwards from the current level to 42 percent of market additions by 2025.

The total mid-point demand for multi-family development in Poipu/Koloa over the next two decades is estimated at 1,678 units. For single-family types the demand will be for 1,162 houses and 1,194 building lots.

Identification of Poipu/Koloa Residential Projects

Existing and Recent/In-Sales Supply

Based on extrapolation of 2000 census data and County planning figures, we estimate the total number of habitable housing units in the Poipu/Koloa study area as of year-end 2004 was approximately 1,400 units. Of these, approximately 942, or 67 percent, have been in major developments constructed since 1970.

A listing of these "modern" projects is shown on Table 5, which is also intended to summarize those which are currently/recently offering units for original purchase. But , as noted, it has been several years since any new inventory has been developed or available for sale.

This is remarkable given the exceptional strength of the Hawaii (and Kauai) real estate market, buyer interest in Poipu, the lack of overhanging supply, and low financing rates. Virtually all other vacation communities in the State have experienced a boom in construction since the late 1990s.

Discussions with study area realtors indicate that were new product available (at any price point), it would quickly be absorbed.

TABLE 4

DIVISION OF PROJECTED DEMAND BY UNIT TYPE
FOR HOUSING UNITS IN POIPU/KALOA 2005 TO 2025
Market Study of the Proposed Village at Poipu Project
Poipu, Kauai, Hawaii

	Periodic Demand (1)				Total	
	2005 to 2010	2011 to 2015	2016 to 2020	2021 to 2025	Demand 2004-2025	Comments
1. Using Minimum Demand Projections						
Single Family Homes	236	146	167	190	738	Historic primary demand type among full-time residents and lower-end of the market. However, the sector will become more attractive to second-home buyers over time. Conversely, as home prices increase more upper-end buyers are moving to buying lot and self-building home.
Percent of Total	32%	30%	28%	26%	29%	
Single Family Lots	207	141	179	226	752	Product has well-established demand in Poipu (see Bayview subdivision) and is becoming more popular alternative in neighbor islands for residents and others.
Percent of Total	28%	29%	30%	31%	30%	
Multifamily Units	295	199	250	314	1,058	Historically makai/resort oriented development focused towards non-resident buyers. Numerous projects proposed for mauka lands will attract greater numbers of residents to this product type in area, becoming only feasible option for many households.
Percent of Total	40%	41%	42%	43%	42%	
Total	**738**	**485**	**595**	**730**	**2,548**	
	100%	100%	100%	100%	100%	
2. Using Maximum Demand Projections						
Single Family Homes	451	296	372	467	1,586	
Percent of Total	32%	30%	28%	26%	29%	
Single Family Lots	395	286	399	556	1,636	
Percent of Total	28%	29%	30%	31%	30%	
Multifamily Units	564	404	559	772	2,298	
Percent of Total	40%	41%	42%	43%	42%	
Total	**1,410**	**985**	**1,330**	**1,795**	**5,520**	
	100%	100%	100%	100%	100%	
Mid-Point						
Single Family Homes	344	221	270	328	**1,162**	
Single Family Lots	301	213	289	391	**1,194**	
Multifamily Units	430	301	404	543	**1,678**	
Total	**1,074**	**735**	**963**	**1,263**	**4,034**	

Source: The Hallstrom Group, Inc.

TABLE 5

SUMMARY OF IN-SALES/RECENT MAJOR POIPU/KOLOA "RESIDENTIAL" DEVELOPMENTS
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii

Development/Project	No. of Units	Type	Original Price Range	Status	Comments

THERE ARE NO NEW MAJOR SINGLE FAMILY OR MULTIFAMILY PROJECTS IN THE STUDY AREA WHICH ARE CURRENTLY OFFERING INVENTORY FOR ORIGINAL SALE.

THE MOST RECENT SINGLE FAMILY SUBDIVISION OFFERING PRODUCT WAS EARLY IN THIS DECADE.

Major single family subdivisions during the past 30 years include:

Name	No. of Lots	Sales Date
Koloa Estates	32	1999-2001
Bayview at Poipu	40	1984-1988
Kiahuna Golf Village	90	1981-1984
Lanai Villas @ Poipu Kai	48	1979-1982
Weliweli Houselots	99	1979-1986
Waikomo	154	1970-1983

All of the lots have been successfully absorbed via original sales.
The substantial majority of lots have been built on, with a flurry of construction during the last four years.

THE MOST RECENT MULTIFAMILY PROJECT OFFERING PRODUCT WAS EARLY IN THIS DECADE.

Major multifamily projects during the past 30 years include:

Name	No. of Units	Sales Date
Regency @ Poipu Kai II	28	2001-2002
Regency @ Poipu Kai I	73	1991-1993
Makanui	22	1980-1981
Poipu Kapili	60	1980-1981
Waikomo Stream Villas	60	1980-1981
Manualoha	54	1979-1981
Poipu Sands	72	1979-1980
Kahala @ Poipu Kai	82	1979-1981
Makahuena	78	1979-1981
Kiahuna Plantation	338	1979-1984
Poipu Shores	40	1976-1977
Sunset Kahili	35	1969-1971

All of the units have been successfully absorbed via original sales.

Source: Hawaii Information Service, The Condominium Guide,, and The Hallstrom Group, Inc.

Proposed Supply

Apart from the Village at Poipu, there are three major projects approved or proposed in the general study area at this time. A fourth, long-planned State sponsored development is now on-hold.

All of the developments are in the vicinity of the subject property and are summarized on Table 6. We are aware of no other major developments preliminarily proposed, announced or otherwise making headway in the entitlement process at this time.

The three market developments shown on the top of the table are all moving strongly forward, and are already, or will be, in construction during 2005. The projects will provide a maximum of 2,555 total units; 1,180 single family homes and 1,375 multi-family units.

It is improbable that all of this inventory will be built, as master plans evolve over time and actual densities invariably fall short of utmost approvals. Further it is unlikely that all of the product will be built within the study time-frame; as noted in the General Plan, "Master-planned projects such as …Kukuiula typically take 30 years or more to build out."

The State owned land easterly abutting the subject was first proposed for development in the 1970s, and was granted initial County entitlements. But it has been on hold for many years, with no change in status likely in the near to mid-term despite the evident need for resident housing.

Based on our investigation, we estimate the potential supply of new housing in the study area over the next 21 years, assuming the projects move reasonably forward into subsequent phases, will be about 2,555 total units; with an outside chance of an additional 400 on the State holding toward the end of the time frame.

Comparison of Demand and Supply Indicators

The demand for new housing opportunities in the Poipu/Koloa study area over the coming 21 years, 2005 through 2025, is estimated at 4,031 total new units (mid-point).

The probable level of new inventory additions during the same time frame will be a maximum of 2,955 units, if all approved developments are built to absolute top densities and the State project moves forward. However, it is likely a smaller number will be actualized.

TABLE 6

SUMMARY OF MAJOR PROPOSED POIPU/KOLOA RESIDENTIAL DEVELOPMENTS
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
EXCLUDES THE SUBJECT PROPERTY AND RESORT-ZONED PROJECTS

	Proposed Units (1)					
Development/Project	**Single Family**	**Multi-Family**	**Total**	**Type**	**Timing**	**Comments**
1. Fully Approved, Moving Forward						
Kukuiula	Mix of SF and MF Unit Types Not Yet Finalized. Past plans show mix of 2:1 SF over MF.		1,500	Mixed Densities of SF & MF.	Entitlements generally in place. Major infrastructure in 2005, product by 2006. Build-out in 25-30 years.	Initial subdivision of 32 lots sold in 1999-2001 (Koloa Estates). Project will also include golf course, comm. timseshare, lodge and other uses.
Kiahuna	180	550	730	SF lots at 8,000 to 15,000 SF, MF at 10 units/acre.	Fully entitled for years. Major development push underway. Build-out in 10-15 years.	Amenities and first SF subdivision built in early/mid 1980s. Project has golf course, tennis ctr, commercial.
Poipu Beach Villas	0	325	325	Resort/Residential units at 13 per acre.	Fully approved, construction to begin in 2005, with build-out within five years.	Unit pre-sale to start in 2005-06. First major MF project mauka Poipu Road. Expect many full-time resident buyers.
Sub-Total (estimated unit mix)	**1,180**	**1,375**	**2,555**			
2. Approved, On-Hold						
Weliweli Expansion	400	0	400	Affordable & Market priced homes.	Project pending. No definite time line for build-out.	State of Hawaii development proposed for 66 acres.
REGIONAL TOTALS	**1,580**	**1,375**	**2,955**			

(1) Unit counts and absorptions are estimates based on discussions with developers, brokers and County agencies and website data.

Source: County of Kauai General Plan, Development websites, project brokers, and The Hallstrom Group, Inc.

Therefore, approved supply will fall short of projected demand by at least 1,000 housing units during the next two decades.

Micro Analysis

The Poipu/Koloa area resort/residential real estate market, like most sectors throughout the state, is currently in the midst of a major up-cycle. The increasing activity began in the late 1990s, was set back briefly by 9/11, and has reached near-record levels during the past two years.

Sales volumes are well up, market times are way down, appreciation is meaningful, and realtors report exceptional interest levels. However, due to the extremely limited inventory available in the region, the number of sales has remained relatively static resulting in rapidly escalating per unit prices.

Single family residential market activity data in the study area from 2000 to 2005 are summarized on Table 7. During this period sales volumes have nearly quadrupled to $88.4 million annually (based on extrapolation of indicators through March) and average sales prices have increased nearly three-fold to $1,472,667, an effective appreciation rate of 20.6 percent compounded annually over the past five years.

Multi-family residential activity for the same period is displayed on Table 8. While the rate of expansion in this sector has been exceptional, it has been below the explosiveness seen in the single family segment. Sales volumes have doubled from 2000 to 2005 to $66.3 million per year as have average sales prices reaching $553,097 per unit, equating to an appreciation rate of 19.2 percent annually.

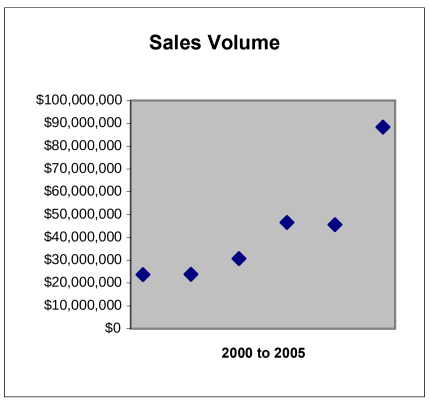
We uncovered no indicators in our research and interviews which demonstrated anything other than the subject area being in the midst of a significant up-cycle. The primary concerns expressed were lack of product ("there are more realtors than units for sale") and rising mortgage rates (which still remain near generationally-low levels).

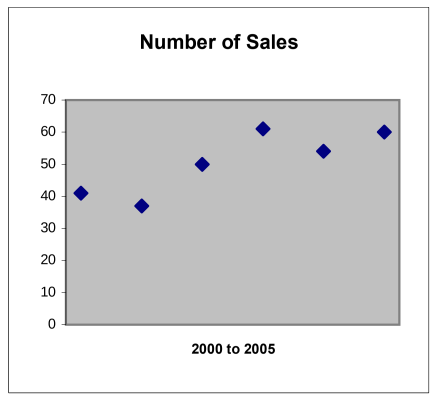
We conclude the micro analysis perspective also provides strong market support for the proposed Village at Poipu project.

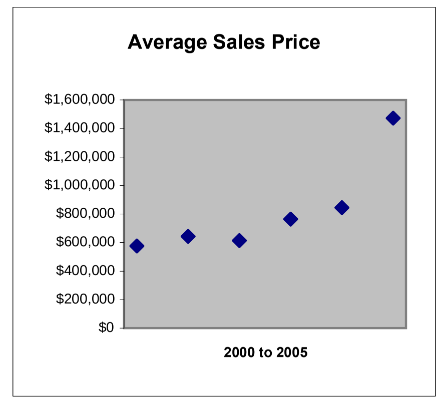
TABLE 7

SUMMARY OF SUBJECT AREA SINGLE FAMILY RESIDENTIAL MARKET ACTIVITY
Market Study of the Proposed Village at Poipu
Poipu, Kauai, Hawaii

Year	2000	2001	2002	2003	2004	2005 (1)
Sales Volume	$23,636,400	$23,830,900	$30,725,000	$46,621,000	$45,622,000	$88,360,000
Percent Annual Change		0.8%	28.9%	51.7%	-2.1%	93.7%
Number of Sales	41	37	50	61	54	60
Percent Annual Change		-9.8%	35.1%	22.0%	-11.5%	11.1%
Average Sales Price	$576,498	$644,078	$614,500	$764,279	$844,852	$1,472,667
Percent Annual Change		11.7%	-4.6%	24.4%	10.5%	74.3%







Note: Includes Tax Map Sections (4) 2-6 through 2-9.

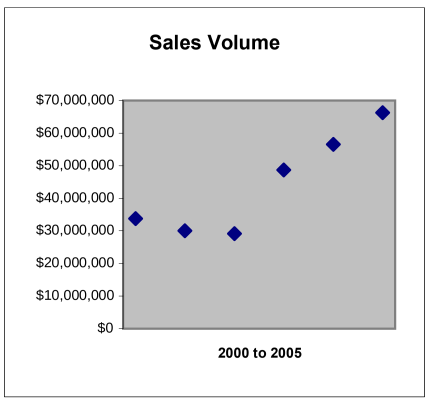
(1) Year-end estimate based on extrapolation of data through March.

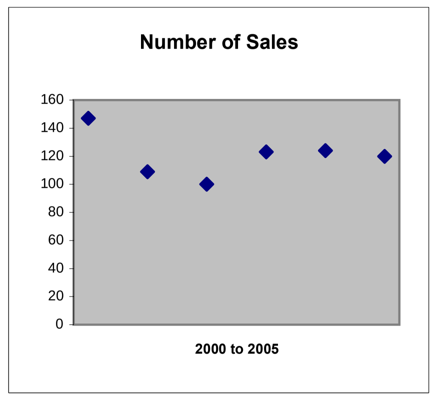
Source: Hawaii Information Service. Kauai MLS and The Hallstrom Group, Inc.

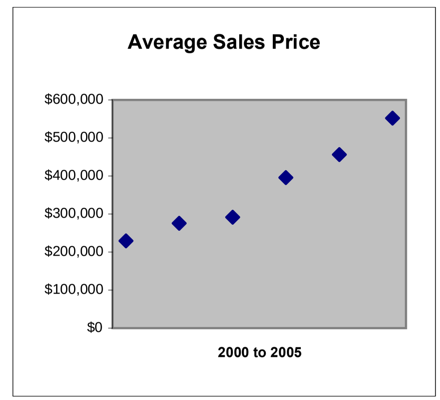
TABLE 8

SUMMARY OF SUBJECT AREA MULTI-FAMILY RESIDENTIAL MARKET ACTIVITY
Market Study of the Proposed Village at Poipu
Poipu, Kauai, Hawaii

Year	2000	2001	2002	2003	2004	2005 (1)
Sales Volume	$33,757,430	$29,998,500	$29,154,600	$48,694,390	$56,579,150	$66,251,600
Percent Annual Change		-11.1%	-2.8%	67.0%	16.2%	17.1%
Number of Sales	147	109	100	123	124	120
Percent Annual Change		-25.9%	-8.3%	23.0%	0.8%	-3.2%
Average Sales Price	$229,642	$275,216	$291,546	$395,889	$456,283	$552,097
Percent Annual Change		19.8%	5.9%	35.8%	15.3%	21.0%







Note: Includes Tax Map Sections (4) 2-6 through 2-9.

(1) Year-end estimate based on extrapolation of data through March.

Source: Hawaii Information Service. Kauai MLS and The Hallstrom Group, Inc.

SUBJECT SITE APPROPRIATENESS AND ABSORPTION CONCLUSIONS

Appropriateness of the Subject Site for the Proposed Use

The 202.8-acre subject property presents a superior opportunity to meet the existing and projected shortfall in residential real estate in the Poipu/Koloa region, specifically addressing the acute community needs for local resident housing and visitor second-home ownership during the next two decades. It has:

- The necessary physical traits (size, shape topography) to support large-scale competitive residential development.
- Direct access onto the main arterials in the community (Poipu and Weliweli Roads) and ready access to the new Ala Kinoiki bypass road.
- Proximity to (outwardly abutting) the central Poipu vacation community core.
- Access to nearby existing utility systems.
- An expanding regional resident population nearby.
- A natural in-fill location within the planned urban expansion corridor of Poipu/Koloa.
- Existing, in-place State and County land use entitlements supportive of much of the proposed development.
- It is adjacent to the primary retail/restaurant/service development in the community (Poipu Shopping Village) and major regional recreational amenities (Kiahuna Tennis Club & Spa and the Kiahuna Golf Course).

The proposed Village at Poipu master plan embodies characteristics that will prove desirable to a wide range of existing and expanding resort/residential purchasers seeking housing units in the subject study area. It maximizes the utilization of urban in-fill/expansion lands by combining residential use-types, permitting varying densities, and implementing planning and architectural guidelines.

Subject Absorption Estimates

Given the evident level of support for the proposed subject inventory as demonstrated by our market study, and that the underlying site is highly appropriate for the envisioned development, it can be reasonably concluded the 350 housing units of the Village at Poipu will achieve reasonable market success upon offering.

This conclusion can be demonstrated through summary application of several techniques, as discussed following.

- The Gross Analysis Method. This is both the simplest and most fundamentally insightful method. It is a mere comparison between demand (for additional units) and supply (proposed units) indicators. If there is more potential demand than potential units, it can be asserted there will be sufficient demand to absorb portions or all of the proposed subject units.

  As our market analysis demonstrated, the supply of resort/residential units in the Poipu/Koloa area will be insufficient to meet forecast regional requirements. The estimated mid-point demand for study area dwelling units over the next 21 years (through 2025) is some 4,031 units. If all of the proposed units are built (including the state-owned project), the total would be a maximum of 2,955 units; more than 1,000 less than demand.

  Even with the 350 Village at Poipu units, the sector will be under serviced by hundreds of units during the projection period.

  This gross analysis indicates the subject units could be absorbed within a five to ten-year projection timeframe, regardless of any additional competitive advantage the inventory may have.

- The Residual Method. In this technique, all of the identified competitive approved resort/residential projects in the study area are placed on a time-line depicting the sales absorption anticipated by the developers, as evidenced by our market survey, or as can be reasonably assumed through historic activity. To the extent these projects fall short of the forecast periodic demand for units in the study region, or exceed the total demand, an undersupply or oversupply situation respectively exists.

By accounting for the total of the units likely to be built in the competitive market during the projection period, it can be reasonably asserted the subject development will "capture" a significant portion of any residual demand. This approach is generally conservative, as it assumes the subject will capture only what is leftover after the other projects garner their anticipated share.

The tabular presentation of this method for the subject units is shown on Table 9.

Each of the identified sources of competitive additional supply are shown at the top of the table along with the reasonably anticipated number of units we consider likely to be constructed, and their periodic absorption over the projection period timeframe. The total demand forecast is shown at the bottom of the respective table, with the resulting over/under supply totals for each period and the residual demand level for the subject product under several capture rate assumptions.

In no single period is there an oversupply situation. In every period during the two-decade projection timeframe demand will exceed supply without the subject inventory.

This method indicates the 350 subject units will require six to ten years to be absorbed.

- The Market Shares Method accounts for the probable competitiveness of the subject residential product regardless of the total level of other inventory being offered. In essence, it is an estimate of how much of the total resort/residential demand in Poipu/Koloa the subject could expect to achieve on an annual basis in light of its locational, pricing, and amenity characteristics.

  This "pure competitiveness" technique is generally moderate to optimistic in application and requires some subjective variables, but is perhaps the most appropriate and "classic" approach.

TABLE 9

PROJECTION OF SUBJECT UNIT ABSORPTION USING THE RESIDUAL METHOD BASED ON TOTAL DEMAND FOR RESIDENTIAL HOUSING IN THE POIPU-KOLOA STUDY AREA

Market Study of Proposed Village at Poipu Project

Poipu, Kauai, Hawaii

Approved/Announced Units Only, Assuming Mid-Point Demand Trends

Project	TOTAL UNITS	2005-2010	2011-2015	2016-2020	2021-2025
Kukuiula	1,500	360	300	300	300
Market Share Percentage		34%	48%	76%	41%
Kiahuna	730	360	300	70	
Market Share Percentage		34%	48%	18%	
Poipu Beach Villas	325	325			
Market Share Percentage		30%			
Weliweli Expansion	400				400
Market Share Percentage					55%
Other Minor Projects/In-Fill	100	25	25	25	25
Market Share Percentage		2%	4%	6%	3%
Totals	**3,055**	**1,070**	**625**	**395**	**725**
Regional Housing Unit Demand	**4,029**	**1,074**	**735**	**960**	**1,260**
Shortage or (Excess) Supply	**974**	**4**	**110**	**565**	**535**
Potential Village at Poipu Residual Subject Demand					
at 97.5% Capture Rate	1,184	4	107	551	522
at 95% Capture Rate	1,153	4	105	537	508
at 92.5% Capture Rate	1,123	4	102	523	495

Source: Maui County, Developers/Agents, & The Hallstrom Group, Inc.

Given the type, location and amenities of the proposed subject product and competitive market, we believe the Village at Poipu could readily achieve an annual market share of 25 to 35 percent of the total competitive demand.

This capture rate, which is reasonable given historic sales standards and the competitiveness of the limited alternatives, would equate to a 29.8 percent share during a mid-point 8.0-year sell-out period. This equates to an average absorption of 43.8 units annually.

We consider the stabilized market share rate to be moderate based on the availability of competitive inventory and their anticipated sales rates. As shown in the residual method, during the subject sales period, there will be only a handful of projects competing for market shares, and just achieving a "fair split" of the demand (regardless of the favorable competitiveness of the subject inventory) will generate capture rates at the projected levels.

Table 10 displays the subject unit market capture absorption forecasts.

Based on our analysis, we forecast the 350 resort/residential subject units will be absorbed in a circa eight-year timeframe from initial offering.

These conclusions based on mid to long-term forecasting models are understated relative to existing vibrancy of the Kauai real estate market. Certainly, the current up-cycle could rapidly absorb the subject inventory if the pre-sale program is timed correctly.

ECONOMIC IMPACT OF THE PROPOSED DEVELOPMENT

The development of the Village at Poipu community will generate significant efforts and expenditures that will favorably impact the Kauai economy on both a direct and indirect basis, increasing the level of capital investment, capital growth and capital flow in the region. The project will pump millions of dollars into South and Central Kauai, expanding the economy, widening the tax base and creating stable long-term employment opportunities.

TABLE 10

SUMMARY OF SUBJECT PROJECTED DEMAND LEVELS
USING THE MARKET SHARES METHOD

Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
Assuming 350 Total Single and Multifamily Units
With Sales to Begin in 2007

Scenario One: Using Conservative Assumptions

Sales Year		Total Regional Residential Demand	Effective Subject Share	Indicated Total Subject Absorption
1	(2007)	123	25.00%	31
2		123	27.50%	34
3		123	30.00%	37
4		123	32.00%	39
5		97	32.00%	31
6		97	32.00%	31
7		97	32.00%	31
8		97	32.00%	31
9		97	32.00%	31
10		119	32.00%	38
11		119	13.50%	16
Totals		**1,215**	**28.82%**	**350**

10.4 year absorption period

Scenario Two: Using Optimistic Assumptions

Sales Year		Total Regional Residential Demand	Effective Subject Share	Indicated Total Subject Absorption
1	(2007)	235	30.00%	71
2		235	32.50%	76
3		235	35.00%	82
4		235	35.00%	82
5		197	19.50%	38
Totals		**1,137**	**30.76%**	**350**

5.6 year absorption period

ANALYSIS MID-POINT			
8.0 year absorption period	**1,176**	**29.76%**	**350**

Source: The Hallstrom Group, Inc

From a direct perspective, the proposed 350-unit resort/residential project will create numerous construction, equipment operator and specialty trade jobs on- and off-site during the planning and emplacement of the infrastructure, and building of the improvements. After completion of the units over an estimated eight-year development period, there will be significant additional employment positions created via the buildings themselves; landscape, service, maintenance, and renovation needs in the course of their use.

Numerous local businesses will enjoy significant profit opportunities arising for contracting companies constructing the improvements, and for local businesses which would supply a substantial portion of the materials needed in the building efforts.

The general island economy also will benefit from the subject development and its employees, which will spend large amounts of wage income in off-site shops, restaurants, and service establishments throughout Kauai, and in purchasing goods and services.

Indirectly, as these wages, profits, and expenditures move through the regional economy, they will have a ripple, or "multiplier," effect--increasing the amount of capital flowing to the entire community as a result of the subject.

Construction, maintenance and other workers earning wages from the Village at Poipu and associated off-site efforts will spend the majority of their income on living and entertainment expenses while supporting and patronizing other island businesses, as will the moderate to upper income guests and residents of the community. Much of this spending would then be re-directed by these businesses to other island industries, with significant portions of these secondary profits in turn being put back through the region's economic and tax structure.

These substantial direct and indirect economic impacts associated with the proposed subject project, as quantified in the following sections, are all the result of the capital investment and entrepreneurship necessary to convert a vacant unused holding to a mixed resort/residential community. The Kauai economy will be meaningfully stimulated by the capital investments and maintenance requirements of the owners and guests.

Capital Investment and Construction Costs

The subject development will bring an estimated $173 million in direct construction capital into Kauai over the eight-year build-out period forecast for the project. A breakdown of the basic expense items, their respective costs and expenditure over time is summarized on Table 11. As with all our models, a ten-year total projection timeframe is used depicting the development, absorption and stabilized use of the community over the initial decade.

Also shown are anticipated contractor and supplier profits flowing to local businesses as a result of the project. All costs were taken from estimates provided by the development team, as cited on the table.

Infrastructure sitework expenses were projected at by the developer at $34.4 million (compiled from Kodani Engineering and Goodfellow Construction estimates) phased over seven years as the development moves from its current status. The infrastructure will be timed to coincide with demand for the dwelling units.

Building construction costs were estimated at a total of $138.6 million in current dollars.

Multifamily units were estimated to have a current average construction cost of $305,000 each. This is based on a 1,400-square-foot unit at $200 per square foot in building expenses, plus $25,000 in common area improvements per unit. The total multifamily component cost is forecast at $40.9 million.

Single-family homes were estimated to have a current average construction cost of $452,500 each, based on a 2,100-square-foot house at $175 per square foot with an additional $50,000 per lot in sitework and landscaping. The total single-family component cost is projected to be $97.7 million.

Our models do not include the 153 potential "Additional Dwelling Units" which could eventually be constructed alongside the "base" homes on some of the single-family lots. These structures could contribute another $60-plus million in construction activity to the island over time.

Not included in the totals are indirect costs such as marketing and sales expenses, developer fees, loan interest and other non-real

TABLE 11

CONSTRUCTION COSTS AND CONTRACTOR AND SUPPLIER PROFIT ESTIMATES
Economic Impact Analysis and Public Cost/Benefit Assessment
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
In Constant Year 2005 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10	Totals
	Infrastructure Emplacement										
	(Approx. 18 Months)										
	Begin Pre-Sale (End Year 1)	First Units Close (End Year 2)	Remaining Housing Units Built and Sold								
Construction Costs											
Infrastructure/Sitework (1)	$5,500,000	$4,809,533	$4,809,533	$4,809,533	$4,809,533	$4,809,533	$4,809,533				**$34,357,200**
MF Construction -- 134 units (2)		$4,575,000	$6,100,000	$6,100,000	$6,100,000	$6,100,000	$6,100,000	$5,795,000			**$40,870,000**
SF Construction -- 216 homes (3)		$15,837,500	$18,100,000	$18,100,000	$18,100,000	$18,100,000	$9,502,500				**$97,740,000**
TOTAL CONSTRUCTION COSTS	$5,500,000	$25,222,033	$29,009,533	$29,009,533	$29,009,533	$29,009,533	$20,412,033	$5,795,000	$0	$0	**$172,967,200**
CONTRACTOR'S PROFIT	**$550,000**	**$2,522,203**	**$2,900,953**	**$2,900,953**	**$2,900,953**	**$2,900,953**	**$2,041,203**	**$579,500**	**$0**	**$0**	**$17,296,720**
SUPPLIER'S PROFIT	**$220,000**	**$1,008,881**	**$1,160,381**	**$1,160,381**	**$1,160,381**	**$1,160,381**	**$816,481**	**$231,800**	**$0**	**$0**	**$6,918,688**

(1) Provided by Knudsen Trust, as estimated/compiled by Kodani Engineering and Goodfellow Construction, January 25, 2005.
Subdivision infrastructure period estimated at 18 months, commencing at beginning of model and completing by middle of Year 2.
(3) Assuming average unit construction budget of $305,000 based on 1,400 square foot unit at $200/SF cost plus $25,000 in common area facilities.
First units begin construction early in Year 2 and are finished by year-end.
(3) Assuming average home construction budget of $452,500 based on 2,300 square foot house at $175/SF cost plus $50,000 site work and landscaping.
First homes begin construction early in Year 2 and are finished by year-end.

Source: Dowling Company, Inc., and The Hallstrom Group, Inc.

property items. The inclusion of these "soft cost" could result in a total capital investment undertaking of more than $200 million.

The direct costs of subject development will infuse an anticipated $21.6 million annually into the Kauai building industry on average over the build-out period. This is the equivalent of a nearly 20 percent boost over recent yearly construction levels. Indirect expenditures could reach an additional $5 million-plus per year.

Employment Opportunities Created

Based on indicators provided by the construction of comparable sized projects and Hawaii industry averages, we have estimated the demand for on- and off-site, full-time equivalent employment positions associated with laying of initial infrastructure systems, building of the finished resort/residential structures, and in providing continuing services to the occupied buildings.

The employment opportunities created by the construction of the subject and long-term maintenance, landscaping and renovations will not all be "new" jobs but will be enhanced opportunities for construction trade workers, youths reaching employment age, and existing local businesses.

It is assumed the off-site/indirect work created will be steered towards existing Kauai supply, equipment providers, and other service companies, which despite the upward movement in the county economy over the past several years remain in an under capacity period relative to the massive development upcycle of the late 1980s.

The subject will provide needed employment opportunities in the construction sector, and supply and building support industries during an estimated eight-year planning, site development and building construction period.

Our employment estimates on are based on full-time equivalent "worker/years," although one worker/year (or circa 2,000 working hours) may be comprised of many employees involved in specialized tasks of a much shorter duration.

Estimates are based on a 10-year modeling period of project construction (eight years) followed by stabilized use (two years). The associated number of employment opportunities created are displayed on the top of Table 12.

Included in our projections on the table are the full-time equivalent (FTE) off-site and support employment opportunities which will be provided to Kauai businesses as a result of the project. Also shown are the total number of maintenance/landscaping workers which will be required to service the project improvements and grounds over time.

The projections are founded on examples provided by various resort/residential developments undertaken on the neighbor islands over the past decade, and via formulae expressing relationships between total worker wages/benefits and construction/operating tasks and costs.

<u>Infrastructure</u> and <u>building construction</u> employment forecasts are taken from estimates by the developer, review of project budgets and ratios of direct costs to job creation (assuming an average wage of $60,000/year plus benefits equal to 25 percent of wages). Our analysis assumes one worker/year per $225,000 in construction contract spending for both infrastructure and finish positions.

<u>Operations/maintenance</u> workers in the condominium complexes and finished homes, including maintenance, landscaping and renovations efforts, were estimated at one full-time equivalent position per 12 units. The average overall pay for these workers is estimated at $27,000 per year.

<u>Off-site employees</u> were estimated at 40 percent of on-site workers, and are comprised of three groups:

- Numerous off-site building industry positions will also be enhanced by the Village at Poipu development, including such jobs as administration, office help, material providers, equipment maintenance and specialty tasks. Analysis of Kauai County labor trends from 1980 through 2004 demonstrate a linkage equal to about 20 to 30 percent between the creation of on-site construction positions and direct off-site employment.

- Off-site support businesses, including contractor/retail/counter sales, fuel providers, shipping, storage and professional services will also benefit. A conservative job creation

TABLE 12

EMPLOYEE JOB COUNT AND WAGE ESTIMATES
Economic Impact Analysis and Public Cost/Benefit Assessment
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
In Constant Year 2005 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10	Total 1 Through 10	Stabilized
Worker Requirements (1)												
Infrastructure/Sitework (2)	24	21	21	21	21	21	21				153	
MF Units Construction (3)		39	52	52	52	52	52	49			347	
SF Home Construction (3)		91	104	104	104	104	54				559	
Operations/Maintenance (4)			9	14	19	24	28	29	29	29	182	29
Off-Site Employees (5)	10	60	74	76	78	80	62	31	12	12	496	12
TOTAL EMPLOYMENT CREATED	34	211	260	267	274	281	217	110	41	41	1,737	41

Development Year	1	2	3	4	5	6	7	8	9	10	Total 1 Through 10	Stabilized
Worker Wages												
Infrastructure/Sitework (6)	$1,466,667	$1,282,542									$2,749,209	
Home & Unit Construction (6)		$7,770,000	$9,324,000	$9,324,000	$9,324,000	$9,324,000	$6,371,400	$2,952,600			$54,390,000	
House Operations/Maintenance (7)			$247,500	$382,500	$517,500	$652,500	$744,750	$787,500	$787,500	$787,500	$4,907,250	$787,500
Off-Site Employees (9)	$312,889	$1,931,209	$2,380,062	$2,444,062	$2,508,062	$2,572,062	$1,985,908	$1,003,221	$373,333	$373,333	$15,884,143	$373,333
TOTAL ANNUAL WAGES PAID	**$1,779,556**	**$10,983,751**	**$11,951,562**	**$12,150,562**	**$12,349,562**	**$12,548,562**	**$9,102,058**	**$4,743,321**	**$1,160,833**	**$1,160,833**	**$77,930,602**	**$1,160,833**

(1) All job counts expressed as "full-time" equivalent position:
(2) Estimated at one worker/year per $225,000 in contract spending
(3) Estimated at one worker/year per $175,000 in contract spending, or 1.74 worker/years for each multifamily unit and 2.59 worker/years for each single family hom
(4) Estimated at one worker/year for each 12 houses/units. Includes workers doing landscaping, repair, renovation, and condominium managem
(5) Includes all off-site jobs created by work efforts at the project; direct and indirect. Estimated at 0.4 off-site positions per on-site positi
(6) Average annual wage of $60,000/worker year
(7) Average annual wage of $27,000/worker year
(8) Average annual wage of $32,000/worker year

Source: Various, and The Hallstrom Group, Inc relationship of five to ten percent relative to on-site positions was used (or, one off-site support worker/year for each ten to 20 on-site worker/years).

- Extrapolation of state Department of Business Economic Development and Tourism (DBEDT) data, along with indicators provided by other state agencies and First Hawaiian Bank studies, demonstrate that each Hawaii worker creates demand for services (and related employment) during and directly attributable to the work day at up to a ten percent ratio. These positions include food businesses, providers of tools and trade goods, payroll/financial and insurance businesses, medical requirements and other secondary indirect/off-site employment.

During the 10-year building and use modeling period of the project, the number of worker/years created on- and off-site by the development varies from 34 to 281 positions annually, totaling 1,737 worker/years over the entire projection timeframe. Of this total, 1,059 worker/years (an annual average of 132 positions during the eight-year construction period) are direct construction-oriented, 182 are on-going maintenance/operating positions; and 496 are off-site worker requirements.

On a stabilized basis after the modeling timeframe, the project will generate some 41 permanent full-time equivalent and/or enhanced employment opportunities--29 directly related to on-site activities, and 12 indirect positions throughout the island.

The average annual on-site job count during the 10-year subject study period of 174 positions represents about a 0.56 percent increase from the total jobs presently available in Kauai County (174 additional jobs per year to the average in February 2005 job count of 31,350). This number can be readily absorbed by the currently available employment pool.

Wage Income Generated

In accordance with data compiled by the state Department of Labor and Industry Relations, PBR Hawaii and the Knudsen Trust, we have estimated the personal income (in the form of wages) which will flow to Kauai workers as a result of the Village at Poipu project.

The average wage of a full-time infrastructure construction worker is estimated at $60,000 per year based on DLIR data for early 2005. For finished building construction workers, the average annual pay will also be about $60,000. Operating and maintenance personnel are forecast to be paid an average of $27,000 per year on average ($13.50 per hour). Off-site building and support industry jobs were estimated to receive an average pay of $32,000 annually.

Overall project average wages are equal to $44,865 per worker/year created during the model period, and $28,313 on a stabilized basis.

Application of these wage estimates to the employment forecasts generates personal income (wage) projections directly resulting from subject development, which were shown at the bottom of Table 12. The wage figures are all presented in constant 2005 dollars, and will undoubtedly escalate over time in accordance with inflationary pressures.

In the first year of development, the "Total Annual Wages Generated" by the subject development effort would be $1,779,556, increasing to a high of $12.5 million, as the number of construction workers peak and maintenance positions are created in year 6. After completion of all construction, the on-going maintenance, off-site/indirect and other employment would result in average annual wages of $1.2 million thereafter.

Over the first 10 years of the development and operation period, on- and off-site, direct and indirect worker wages would total $77.9 million.

Development Costs as Profit Income

While the significant majority of the materials needed to build the subject industrial and commercial structures must be imported to Kauai, a portion of the construction costs spent in the development will flow to local businesses in the form of contractor profits and supplier profits.

Typically, within the industry net contractor profit margins are expected to be at 8 to 20 percent of total construction costs. We have used a conservative ten percent figure. Supplier profits were extrapolated at four percent of total costs; generally supplies/materials equate to 50 to 60 percent of total cost, with a profit margin for the supplier of six to eight percent.

Application of these estimates to the forecast development parameters of the subject project was shown on Table 11.

The total Contractor's Profit ranges from $550,000 to $2.9 million per year, with a cumulative profit of $17.3 million over the three-year construction period. The total annual Supplier's Profit ranges from a low of $220,000 to a high of $1.2 million, and equates to $6.9 million over the development time-frame.

Population, Income and Expenditures

The 350 subject units will be purchased by a variety of local residents, second homeowners and in-migrants. Together these groups and guests will contribute to the Kauai economy during the use of the subject units in the form of discretionary expenditures and (for full-time residents) household income levels.

Table 13 displays our population, discretionary expenditures, and household income estimates for the subject project.

For the single-family homes, it was estimated that 60 percent would be used by full-time residences and 40 percent by part-time/second home users. For the full-time component, an average household size of 3.5 persons was assumed. For the part-time users, it was estimated the homes would be occupied 20 percent of the time with an average party size of 3.8 persons.

For the multi-family units, it was estimated that 50 percent would be used for full-time residency and 50 percent by part-time users. In the resident units, an average household size of 2.1 persons was employed. For the part-time units, it was estimated they would be occupied 30 percent of the time with an average party size of 2.8 persons.

At built-out, the stabilized de facto population of the project would be some 1,145 persons, comprised of 595 full-time residents and 550 second-home owners and guests, divided as follows:

TABLE 13

DE FACTO POPULATION, DISCRETIONARY EXPENDITURES AND RESIDENT HOUSEHOLD INCOMES
Economic Impact Analysis and Public Cost/Benefit Assessment
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
In Constant Year 2005 Dollars

Development Year	2	3	4	5	6	7	8	9	Stabilized 10
Cumulative Residential Development									
MF Unit Construction	15	35	55	75	95	115	134	134	134
SF Home Construction	35	75	115	155	195	216	216	216	216
Total Finished Homes	50	110	170	230	290	331	350	350	350
Average Daily Resident/Guest Population									
MF Full-Time Residents (1)	16	37	58	79	100	121	141	141	141
SF Full-Time Residents (2)	74	158	242	326	410	454	454	454	454
MF Part-Time Residents (3)	21	49	77	105	133	161	188	188	188
SF Part-Time Residents (4)	53	114	175	236	296	328	328	328	328
Guests (5)	5	11	17	23	29	33	35	35	35
Total De Facto Population	168	368	568	768	968	1,097	1,145	1,145	1,145
Total Full-Time Resident Population	89	194	299	404	509	574	594	594	594
Estimated School Age Children (6)	22	49	75	101	127	144	149	149	149
Estimated Public School Children (7)	15	32	49	67	84	95	98	98	98
RESIDENT DISCRETIONARY (TAXABLE) EXPENDITURES (8)	$8,172,810	$17,943,000	$27,713,190	$37,483,380	$47,253,570	$53,812,124	$56,670,531	$56,670,531	$56,670,531
Total Years 1 -10	$305,719,136								
FULL-TIME RESIDENT INCOME (9)	$5,189,850	$11,381,250	$17,572,650	$23,764,050	$29,955,450	$34,070,910	$35,800,860	$35,800,860	$35,800,860
Total Years 1 -10	$229,336,740								

(1) 50 percent of units estimated to be used as full-time residences, with average household size of 2.1 persons.
(2) 60 percent of homes estimated to be used as full-time residences, with average household size of 3.5 persons.
(3) 50 percent of units estimated to be used as part-time (second home) residences, occupied 30% of time with average party size of 2.8 persons.
(4) 40 percent of homes estimated to be used as part-time (second home) residences, occupied 20% of time with average party size of 3.8 persons.
(5) Estimated average guest population (not included in full-time or part-time categories) of 1 guest per 10 finished homes.
(6) Persons between the ages of three and 19 enrolled in public and private schools, estimated at 25% of total full-time resident population.
(7) Persons enrolled in public schools, estimated at 16.5 percent of the full-time resident population.
(8) Estimated at 60% of full-time resident household income, and at $175 per capita daily for part-time residents and guest populations.
(9) Estimated at $182,100 annually per full-time resident household. Three times the Kauai average, and as would be necessary to support conventional mortgage.

Source: Various, and The Hallstrom Group, Inc.

Single-Family Full-Time Residents	454
Multi-Family Full-Time Residents	141
Single-Family Part-Time Residents	328
Multi-Family Part-Time Residents	188
Guests (Estimated at One Per 10 Units)	35
Total Average De Facto Population	**1,145**

It is estimated that about 149 of the full-time resident population (25 percent) will be juveniles of school age, of which 98 (or 16.5 percent of the total resident population) would attend public schools.

The population of the project will place significant discretionary expenditure dollars into the Kauai economy. In light of the cost of the finished homes, the residents and other users will be in the top household income brackets with substantial available income for such spending. The vacation/guest orientation of the users will further contribute to the high amount of discretionary funds.

We estimate that full-time resident households will spend about 60 percent of their total income on local discretionary items based on the most recent data. The daily per capita spending by second-home users, and their guests in the Kauai economy will be on average $175, which is moderately above what the typical Kauai visitor spends daily on non-lodging purchases (commensurate with the relative upscale subject project quality). This pays for all food, entertainment, household goods, locally purchased fixtures and furnishings, utilities, clothing and other daily items.

By build-out, the total resident owner/guest discretionary expenditures made by subject project users in the local market will be at $56.7 million annually on a stabilized basis, in 2005 dollars. During the 10-year development and operation model period, the total sum of these expenditures will be $305.7 million.

The total full-time resident income amount was quantified for use in estimating discretionary expenditures and state income taxes to be paid. In order to conventionally qualify for a unit with prices likely to be sought for the subject estate homes, a household income of upwards of three times the islandwide average (or $182,100) per year is minimally necessary. We recognize this amount could range widely upwards, and consider this projection moderate.

On a stabilized basis after build-out, the total annual full-time taxable resident income at the subject would be some $35.8 million. Some of the resident and virtually all of the guest expenditures will be "new" dollars on Kauai, providing a true economic expansion.

Summary of Direct, Local Economic Impacts

The various direct, local economic impacts which will flow to the subject region as a result of the subject development are summarized on Table 14.

The wages, profits and discretionary expenditures figures are taken from previously presented tables. The home maintenance, repairs and upgrades revenues were calculated based on an estimated average of $1,000 per unit monthly beginning in year 3, or $4.2 million total annually on a stabilized basis.

The annual Total Base Economic Impact increases from $2.5 million in year 1 of the development effort to a high of $69.7 million in year 7 (in 2005 dollars). Over the decade long development and operation modeling period, the total is $341.7 million. Fueled by unit maintenance and resident/guest expenditures, the estimated stabilized annual base impact thereafter is $62.0 million.

These dollars will be spent, then re-spent, on goods and services on the island, diminishing in impact on the local economy with each turnover as a portion flows off Kauai for goods, services and financing commitments. First Hawaiian Bank studies have concluded the appropriate economic multiplier rates in Hawaii are from 1.2 to 3.5 times (or 20 to 250 percent) of the base impact amount. Mainland studies (by the Urban Institute and others) tend toward the upper end of this range, and reach multipliers as high as 4.0.

Due to the need to import more than 85-plus percent of supplies/goods used on Kauai, the multiplier impact for the island is not as great as for mainland locales, particularly for construction-based expenditures. We have therefore tested multiplier rates at the mid-point of the market spectrum, ranging from 1.5 to 3.5 times.

On a conservative basis, using a relatively low-end multiplier effect ratio of 2.0, the total overall direct impact on the Kauai island economy resulting from the Village at Poipu project would be $683.3 million over the 10-year projection period (in constant 2005 dollars).

TABLE 14

SUMMARY OF ECONOMIC IMPACTS ASSOCIATED WITH DEVELOPMENT
Economic Impact Analysis and Public Cost/Benefit Assessment
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
In Constant Year 2005 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10	Total Years 1 Through 10	Stabilized
ANNUAL WAGES GENERATED	$1,779,556	$10,983,751	$11,951,562	$12,150,562	$12,349,562	$12,548,562	$9,102,058	$4,743,321	$1,160,833	$1,160,833	$77,930,602	$1,160,833
CONTRACTOR'S PROFIT	$550,000	$2,522,203	$2,900,953	$2,900,953	$2,900,953	$2,900,953	$2,041,203	$579,500			$17,296,720	
SUPPLIER'S PROFIT	$220,000	$1,008,881	$1,160,381	$1,160,381	$1,160,381	$1,160,381	$816,481	$231,800			$6,918,688	
HOME MAINTENANCE, REPAIRS AND UPGRADES (1)			$1,320,000	$2,040,000	$2,760,000	$3,480,000	$3,972,000	$4,200,000	$4,200,000	$4,200,000	$26,172,000	$4,200,000
DISCRETIONARY EXPENDITURES		$8,172,810	$17,943,000	$27,713,190	$37,483,380	$47,253,570	$53,812,124	$56,670,531	$56,670,531	$56,670,531	$213,353,523	$56,670,531
TOTAL BASE ECONOMIC IMPACT	**$2,549,556**	**$22,687,646**	**$35,275,897**	**$45,965,087**	**$56,654,277**	**$67,343,467**	**$69,743,866**	**$66,425,152**	**$62,031,364**	**$62,031,364**	**$341,671,532**	**$62,031,364**
Multiplier Effect Ratio	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
TOTAL OVERALL IMPACT	**$5,099,111**	**$45,375,292**	**$70,551,794**	**$91,930,174**	**$113,308,554**	**$134,686,934**	**$139,487,732**	**$132,850,305**	**$124,062,729**	**$124,062,729**	**$683,343,064**	**$124,062,729**

(1) Estimated at $1,000 per unit per month, beginning in Year 3.

Source: Various, and The Hallstrom Group, Inc.

On a stabilized annual basis thereafter, the overall impact would be at $124.1 million.

PUBLIC COSTS/BENEFITS ASSESSMENT

The purpose of this analysis is to delineate the direct areas in which the proposed subject resort/residential development will potentially impact the sphere of public agency resources, and quantify (where possible) the costs of providing expanded services to the project, versus the economic benefits that accrue to the community through an increase in local and state tax payments.

For most developments, potential direct costs to governmental services and programs include:

-- Police Protection
-- Fire Protection
-- Public Oversight Agencies
-- Infrastructure Services
-- Recreational Demands
-- Educational Needs
-- Infrastructure Costs
-- Various Other Services and Financial Commitments

However, as a privately built master planned residential community many of these costs will not be increased on the state or county levels as a direct result of the proposed Village at Poipu. There will be minorly increased educational or recreational needs directly attributable to the subject development; the major off-site public infrastructure items (roadways and primary water/sewer mains) are already in place; and the development will require no specific public subsidies, welfare services, bonding or capital improvements.

Direct tax benefits to the state and county coffers will primarily flow from the project and its operation over time from three major sources:

-- Real Property Taxes
-- Gross Excise Tax Receipts
-- State Income Taxes

Some cost/benefit issues are considered as off-setting, or "a wash," as the cost of the services to the government is theoretically directly reimbursed in the form of user fees. Building permits and utility hook-up fees are two prime examples. Other such items include workers compensation premiums and benefits, utility operations and associated use billing rates, and business oversight/registration verses licensing fees. These items are excluded from this study.

A concern of this analysis is the integration of the subject project into the overall state and Kauai governmental services plan on both an actual and pro rata perspective.

From an actual public service cost perspective to Kauai and state agencies, the subject will represent only a fraction of the county and state resort plant and overall urban lands in use. Given the vast number of housing units, resorts, businesses, and agricultural lands on the island, it is difficult to assert that of themselves the subject club and users will create the need for meaningful expansion of existing public services.

No new schools, parks, highways, recreational facilities, service agencies, hospitals, or other public enterprises will be required specifically because of this project. The impact on the total regional land base will be minimal. Public safety facilities in Poipu and Koloa are reasonably proximate, generally have the personnel and equipment to service the businesses and buildings in the club, and will expand with overall community growth over the next decade as the project is built.

However, the need for additional services is a cumulative effect, each project, each resident, tourist and, to a lesser degree, business adds a little bit to the community base until increased "need thresholds" are reached.

In regard to some services, the effective actual impact may not be apparent from a cost perspective, merely creating nominally greater demands which can be readily met through existing agencies and facilities without the need for additional workers or funds.

Our analysis of Kauai County and state budgets indicate the actual effect of governmental services relating to the subject would not create the need to expand county and state services in and of itself.

As an alternative to actual cost estimates, which are often disparate as they inherently cannot provide for unexpected and/or atypical items, it is most common to project public costs on a per capita allocation.

This approach is generally appropriate for resort and residential developments, as the substantial portion, but not entirety of public costs and services generally accrue to where a person lives (or in the case of a tourist, where they are lodging).

Government services are holistic in nature, providing a foundation throughout a community, regardless of actual, specific impact on any given land holding. A resort development or business may not have a need for parks or schools, but they are essential to the patrons and workers and create the climate in which the resort or business operates. Similarly, government administration, capital projects and public welfare items may have no direct relation to a particular project, but provide the economic underpinnings that enhances overall economic success.

In order to meaningfully quantify public costs that may be associated with the subject development, we have therefore looked at the issue from both perspectives, on an actual cost basis and on a per capita allocation basis.

Public Costs

Actual Costs

Kauai County will directly incur several areas of cost increases as a result of the Village at Poipu, primarily in regards to emergency services. Based on analysis of response frequencies, time/cost data, and past discussions with affected agencies, we have made general allowances for these items as summarized below.

Police/Enforcement -- Using a base cost of $140 per hour for a responding officer (wages and benefits for responding/support/ administrative personnel, overhead, capital costs, and amortized equipment), we estimate the annual additional police/enforcement cost to Kauai County on a stabilized basis after project build-out will be about $159,040.

This is comprised of:

- For miscellaneous calls per week at an average of two total officer hours each. (2 hrs. x $140/hr. x 4 x 52 = $58,240)

- Four "minor" incidents/traffic accidents each month requiring on average five hours of officer time. (5 hrs. x $140 x 4 x 12 = $33,600)

- Two "major" incidents/traffic accidents each month requiring on average of 20 hours of officer time. (20 hrs. x $140 x 2 x 12 = $67,200)

This demand of 1,136 hours is the equivalent to 56.8 percent of one new officer position (2,000 total hours).

Fire Protection -- Our forecasts are based on a crew cost of $800/hour (four to five firemen, wages, benefits, overhead and amortized equipment). Using this method, we estimate that at build-out, the yearly additional costs to Kauai County resulting from the Village at Poipu is $134,400 per year.

This is comprised of:

- Two "minor" fire/rescue events per month requiring one crew for a total of three hours (response and/or clean-up). (3 hrs. x $800/hr. x 2 x 12 = $57,600)

- One "major" fire/rescue event every two months requiring two crews for a total of eight hours each. (2 crews x 8 hrs. x $800/hr. x 6 = $76,800)

Emergency Medical Response -- This is based on average cost per response of $500, with an average of four calls per month. The total cost to the county would be $24,000 per year on a stabilized basis after build-out. ($500/response x 4 per month x 12 = $24,000)

Road Maintenance -- An allowance of $20,000 per year was made for this item to provide maintenance to Poipu, Weliweli and Hapa Roads.

The total annual "actual" cost to the county on a stabilized basis at build out of the subject development is estimated at $337,440. This cost would be reached on an escalating basis over time, beginning in year 3 and increasing as the community is finished and populated.

State of Hawaii costs would include nearby highway frontage work, inspections and other minor oversight duties. An allowance of

$75,000 per year was made for these items, increasing to the stabilized level as the project is built out.

Additionally, it is possible that up to 98 resident children (the count projected by the demographic formula) could enter the public school system. The cost per student in public schools statewide is presently at about $7,500 per year. We have used a stabilized allowance of $8,000 per potential student, or $784,000 in maximum student costs to the state each year.

The total state costs on an "actual" stabilized basis would be about $859,000 annually.

Per Capita Costs

An alternative method for determining public costs is through per capita expenditures incurred by the State of Hawaii and Kauai County in accordance with the de facto population area of the jurisdiction. This is founded on the principal that each individual on the island equitably benefits from all governmental costs, regardless of type or focus throughout the day, with each new member of the community (whether resident or visitor) creating a proportionate new cost burden in their daily home and working life.

As previously noted, this is the standard method for resort and residential application as the majority of costs are viewed as accruing to the housing or lodging aspects of a persons lifestyle and land use. We have included it as a means of demonstrating the overall public fiscal impact potential of the proposed subject project even when viewed from this maximum potential cost perspective. We consider this approach as setting the absolute upper limit on all public costs (actual, indirect and inferred).

However, not all public costs accrue solely to a persons place of residence. Government services and oversight are also a vital component of the commercial community, and industrial, resort and retail/service land uses must also bear a proportionate share of their operational and consumer-related public expenses.

We have therefore estimated that two-thirds of each persons per capita governmental services impact (whether resident or tourist) is attributable to their dwelling place; the other third to the non-residential uses they patronize.

According to the state Department of Budget and Finance database, the state expects to spend a total of $8.0 billion on services, salaries, infrastructure, and financing in fiscal 2005. The total de facto population in the state on an average daily basis at year-end 2004 was about 1,450,000 persons, including residents, tourists, and military personnel.

The per capita expenditure by the state will thus be about $5,520 for 2005, a nominal increase from 2004. From 1979 through 2004, state government expenditures increased at a rate of just under five percent annually compounded.

The stabilized average de facto population on-site at the subject at build-out will be 1,145 persons, a figure reached in year 8 of the development model. Using the allocated state cost per de facto "resident" of $3,643 per year in allocated costs ($5,520 in total per capita costs times a 66 percent allocation to the dwelling unit), the total annual "costs" to the state purse at stabilization by the project using the per capita allowance method would be $4,172,266 in constant year 2005 dollars.

Analyzed on a similar basis, Kauai County's budget for the local government in fiscal year 2005 is circa $109,200,000, which represents an escalation over time of more than four percent compounded annually since 1995.

The current de facto population in Kauai County is some 78,000 persons. The resulting de facto per capita county expenditure for this year is therefore anticipated to be about $1,400. Applying the 66 percent allocation attributable to the residential land use for each subject de facto resident, results in a per capita allocated county government cost of $924 per person.

Village at Poipu at build out would be about $1,058,183 annually in costs to the county government on a stabilized basis (1,145 de facto residents x $924).

Total Public Costs -- On a per capita allowance cost basis, the state and county expenses associated with the subject development would range from $769,345 in year 2 of the project (the first year of unit occupancy) to a stabilized maximum of $5,230,449 at build-out in year 8 and beyond, in constant 2005 dollars.

On an actual cost basis, which we acknowledge may be an atypical perspective and a minimized accounting of direct expenditures, the total governmental costs at build-out to the state and county would be $1,196,440 annually.

Public Fiscal Benefits

Real Property Taxes -- Property taxes paid by landowners in the subject project were calculated using the 2005 tax rates for both land and buildings, improved or unimproved.

The assessed values for the improvements were based upon the estimated direct costs for each unit, plus an allowance of 20 percent for indirect, financing, profits and other costs which would inure to the structures. The total estimated assessed values of the finished units upon completion is $166.3 million.

The assessed values for the land component was estimated at $50.7 million (202.8 acres at $250,000 per acre) for the site in its pre-developed state during year 1 of our model. This equates to an underlying assessed land value equal to $144,857 per proposed unit.

"As Is," it was assumed the site would be taxed as single-family residential at the rate of $5.14 per $1,000 assessed valuation. After subdivision, the house lots, with an estimated value of $350,000 each, would be taxed at the same rate. The multi-family units would have a land assessment of $50,000 per unit and a mill rate of $8.20.

The single-family homes were assumed taxed at a rate of $4.30 per $1,000 in value, and the multi-family units at $7.95.

All real property value of the subject holding is assumed to be vested in the completed "salable" and operating components, with no assessment placed against open spaces, roads, or other systems.

The total real property tax to be paid to Kauai County in 2005 dollars ranges from $260,598 in year 1 of development, to a stabilized level of $1,338,390 at build-out in year 8 and beyond. The aggregate real property taxes paid over the 10-year study time-frame will be $10.0 million.

State Income Tax -- The state will receive income taxes from three sources:

- the wages of the workers associated with the construction, maintenance, and operation of the Village at Poipu components;

- the household incomes of full-time residents in the community; and

- the corporate profits from contractors and suppliers serving the construction phase of the development, and as generated by on-going maintenance and operations.

According to DBEDT data, individual State of Hawaii income tax liability as a ratio to gross income has ranged from 5.5 to 5.9 percent during the past decade, with the more current figures tending toward the mid to upper-end of the range. We have employed an effective tax rate of 5.80 percent of gross income for individual workers and full-time residents.

The effective tax rate for the corporate income is estimated at 2.00 percent of gross operating profits, based on available DBEDT statistics.

The total income tax revenues to be received by the state are projected at $110,914 in the first year of construction increasing to a maximum level at year 7 of $2.7 million annually in constant 2005 dollars.

On a stabilized basis, after build-out, the permanent maintenance workers, off-site workers, and full-time project residents would pay an annual state income tax of $2.3 million. Over the 10-year modeling period, the cumulative income taxes paid are estimated at $18.8 million.

We have not included any corporate income or other taxes which will be paid by the developers as a result of their profits from undertaking the subject development, or from the secondary jobs created by the discretionary spending of workers and businesses. Such items have the potential to be substantial contributions to the state coffers.

State Gross Excise Tax -- This 4.166 percent of expenditures tax was applied against:

- the total estimated construction contract costs;

- the total allocated gross sales maintenance, landscaping and renovations operations; and

- the discretionary expenditures of the de facto resident and worker populations of the subject.

The anticipated state excise tax receipts arising from the subject development grow from an estimated $266,198 in the first year of development to a peak of $3.6 million. Over the 10-year study period, the receipts total $25.0 million and stabilize at circa $2.6 million per year.

We have not included any excise tax revenues associated with the direct, local "multiplier effect" expenditures on Kauai, or those created in the secondary market by the suppliers to the maintenance operating or secondary worker expenditures.

Total Public Benefits (Revenues) -- In constant 2005 dollars, the aggregate annual tax revenues flowing from the subject development at full project build-out range from:

- $260,598 to $1.3 million per year for Kauai County, stabilizing over time at the higher figure, totaling $10 million over the 10-year development projection model;

- $377,112 to $6.2 million annually for the State of Hawaii, stabilizing at $4.8 million per year, and cumulatively at $43.8 million over the 10-year forecast period; and

- $637,710 to $7.4 million per year for total tax receipts (county and state), totaling $53.9 million for the initial 10 years of the Village at Poipu community, and stabilizing at $6.2 million per year.

Correlation

Our public cost/benefit assessment model is displayed on Table 15, depicting the correlation of public service costs (per capita allocation basis) with the anticipated tax revenue benefits.

Table 16 summarizes our costs/benefits findings on both an actual cost and per capita allowance basis for the Village at Poipu.

As can be seen, regardless of the cost methodology adopted, in no single year do public coffers suffer a net loss.

TABLE 15

PUBLIC COST/BENEFIT SUMMARY TABLE
Economic Impact Analysis and Public Cost/Benefit Assessment
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
In Constant Year 2005 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10	Total Years 1 Through 10	Stabilized
PUBLIC BENEFITS (Revenues)												
1. REAL PROPERTY TAXES												
Cumulative Assessed Values (1) (2)												
Improvements		$24,495,000	$53,535,000	$82,575,000	$111,615,000	$140,655,000	$159,378,000	$166,332,000	$166,332,000	$166,332,000		$166,332,000
Land	$50,700,000	$82,300,000	$82,300,000	$82,300,000	$82,300,000	$82,300,000	$82,300,000	$82,300,000	$82,300,000	$82,300,000		$82,300,000
Total Assessed Value	$50,700,000	$106,795,000	$135,835,000	$164,875,000	$193,915,000	$222,955,000	$241,678,000	$248,632,000	$248,632,000	$248,632,000		$248,632,000
TOTAL REAL PROPERTY TAXES	**$260,598**	**$575,307**	**$731,542**	**$887,778**	**$1,044,013**	**$1,200,248**	**$1,300,978**	**$1,338,390**	**$1,338,390**	**$1,338,390**	**$10,015,634**	**$1,338,390**
2. STATE INCOME TAXES												
Taxable Personal Income	$1,779,556	$16,173,601	$23,332,812	$29,723,212	$36,113,612	$42,504,012	$43,172,968	$40,544,181	$36,961,693	$36,961,693	$307,267,342	$36,961,693
Taxable Corporate Profits	$385,000	$2,582,823	$3,930,567	$4,965,186	$5,999,805	$7,034,424	$7,127,815	$6,408,703	$6,003,053	$6,003,053	$50,440,431	$6,003,053
Personal Taxes Paid	$103,214	$938,069	$1,353,303	$1,723,946	$2,094,590	$2,465,233	$2,504,032	$2,351,563	$2,143,778	$2,143,778	$17,821,506	$2,143,778
Corporate Taxes Paid	$7,700	$51,656	$78,611	$99,304	$119,996	$140,688	$142,556	$128,174	$120,061	$120,061	$1,008,809	$120,061
TOTAL STATE INCOME TAXES	**$110,914**	**$989,725**	**$1,431,914**	**$1,823,250**	**$2,214,586**	**$2,605,921**	**$2,646,588**	**$2,479,737**	**$2,263,839**	**$2,263,839**	**$18,830,314**	**$2,263,839**
3. STATE GROSS EXCISE TAX												
Taxable Transactions												
Construction Contracts	$5,500,000	$25,222,033	$29,009,533	$29,009,533	$29,009,533	$29,009,533	$20,412,033	$5,795,000			$172,967,200	
Disposable Income Purchases	$889,778	$13,664,686	$23,918,781	$33,788,471	$43,658,161	$53,527,851	$58,363,152	$59,042,192	$57,250,948	$57,250,948	$401,354,967	$57,250,948
Home Maintenance			$1,320,000	$2,040,000	$2,760,000	$3,480,000	$3,972,000	$4,200,000	$4,200,000	$4,200,000	$26,172,000	$4,200,000
Total Taxable Transactions	$6,389,778	$38,886,719	$54,248,315	$64,838,005	$75,427,695	$86,017,385	$82,747,186	$69,037,192	$61,450,948	$61,450,948	$600,494,167	$61,450,948
TOTAL STATE EXCISE TAX	**$266,198**	**$1,620,021**	**$2,259,985**	**$2,701,151**	**$3,142,318**	**$3,583,484**	**$3,447,248**	**$2,876,089**	**$2,560,046**	**$2,560,046**	**$25,016,587**	**$2,560,046**
TOTAL GROSS PUBLIC REVENUES												
To Kauai County (Item #1)	$260,598	$575,307	$731,542	$887,778	$1,044,013	$1,200,248	$1,300,978	$1,338,390	$1,338,390	$1,338,390	$10,015,634	$1,338,390
To State (Items #2 & 3)	$377,112	$2,609,746	$3,691,899	$4,524,401	$5,356,903	$6,189,405	$6,093,836	$5,355,826	$4,823,886	$4,823,886	$43,846,901	$4,823,886
AGGREGATE TAX REVENUES	**$637,710**	**$3,185,053**	**$4,423,442**	**$5,412,179**	**$6,400,916**	**$7,389,653**	**$7,394,814**	**$6,694,216**	**$6,162,276**	**$6,162,276**	**$53,862,535**	**$6,162,276**
PUBLIC COSTS (Expenses)												
By Kauai County		$155,648	$340,263	$524,878	$709,493	$894,109	$1,013,415	$1,058,183	$1,058,183	$1,058,183	$6,812,356	$1,058,183
By State of Hawaii		$613,697	$1,341,608	$2,069,520	$2,797,431	$3,525,342	$3,995,752	$4,172,266	$4,172,266	$4,172,266	$26,860,148	$4,172,266
TOTAL PUBLIC COSTS		**$769,345**	**$1,681,871**	**$2,594,398**	**$3,506,925**	**$4,419,451**	**$5,009,168**	**$5,230,449**	**$5,230,449**	**$5,230,449**	**$33,672,504**	**$5,230,449**
TOTAL NET PUBLIC BENEFITS												
To Kauai County	$260,598	$419,659	$391,279	$362,899	$334,519	$306,139	$287,562	$280,207	$280,207	$280,207	$3,203,277	$280,207
To State of Hawaii	$377,112	$1,996,049	$2,350,291	$2,454,882	$2,559,472	$2,664,063	$2,098,084	$1,183,560	$651,620	$651,620	$16,986,754	$651,620
AGGREGATE NET BENEFITS	**$637,710**	**$2,415,708**	**$2,741,570**	**$2,817,781**	**$2,893,992**	**$2,970,202**	**$2,385,646**	**$1,463,767**	**$931,827**	**$931,827**	**$20,190,031**	**$931,827**

Source: The Hallstrom Group, Inc

TABLE 16

SUMMARY OF ANNUAL PRIMARY GOVERNMENTAL TAX RECEIPTS AND PUBLIC SERVICE COSTS

Economic Impact Analysis and Public Cost/Benefit Assessment
Market Study of Proposed Village at Poipu Project
Poipu, Kauai, Hawaii
In Constant Year 2005 Dollars

State of Hawaii

	Actual Cost Comparison					Per Capita Allocation Comparison				
On Stabilized Basis At Build-Out	Receipts	-	Costs	=	Net Benefits or (Costs)	Receipts	-	Costs	=	Net Benefits or (Costs)
Amount per Year	$5,022,807		($859,000)		$4,163,807	$5,022,807		($4,172,266)		$850,541

Kauai County

	Actual Cost Comparison					Per Capita Allocation Comparison				
On Stabilized Basis At Build-Out	Receipts	-	Costs	=	Net Benefits or (Costs)	Receipts	-	Costs	=	Net Benefits or (Costs)
Amount per Year	$1,338,390		($337,440)		$1,000,950	$1,338,390		($1,058,183)		$280,207

Source: The Hallstrom Group, Inc.

CERTIFICATION

The undersigned do hereby certify that, to the best of our knowledge and belief, the statements of fact contained in this report are true and correct. It is further certified that the reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are our personal, impartial, and unbiased professional analyses, opinions, and conclusions. We further certify that we have no present or prospective interest in the property that is the subject of this report, and have no personal interest with respect to the parties involved. We have no bias with respect to the property that is the subject of this report or the parties involved with this assignment. Our engagement in this assignment was not contingent upon developing or reporting predetermined results. Our compensation for completing this assignment is not contingent upon the development or reporting of a predetermined value or direction in value that favors the cause of the client, the amount of the value opinion, the attainment of a stipulated result, or the occurrence of a subsequent event directly related to the intended use of this appraisal. The appraisal analyses, opinions, and conclusions were developed, and this report has been prepared, in conformity with the requirements of the Code of Professional Ethics and Standards of Professional Appraisal Practice of the Appraisal Institute, and the Uniform Standards of Professional Appraisal Practice. The use of this report is subject to the requirements of the Appraisal Institute relating to review by duly authorized representatives. The undersigned certify that they have made personal inspections of the property that is the subject of this report. No other persons provided significant real property appraisal assistance other than the undersigned.

The Appraisal Institute conducts programs of continuing education for their designated members. As of the date of this report, James E. Hallstrom, Jr. has completed the requirements of the continuing education program of the Appraisal Institute.

James E. Hallstrom, Jr., MAI, CRE
Hawaii State Certified
General Appraiser, CGA-178
Exp. Date December 31, 2005

Tom W. Holliday

Tom W. Holliday

/as 4551_R01

THE HALLSTROM GROUP INC.
REAL ESTATE
CONSULTANTS
& APPRAISERS

PROFESSIONAL BACKGROUND AND SERVICES

The Hallstrom Group, Inc. is a Honolulu based independent professional organization that provides a wide scope of real estate consulting services throughout the State of Hawaii with particular emphasis on valuation studies. The purpose of the firm is to assist clients in formulating realistic real estate decisions. It provides solutions to complex issues by delivering thoroughly researched, objective analyses in a timely manner. Focusing on specific client problems and needs, and employing a broad range of tools including after-tax cash flow simulations and feasibility analyses, the firm minimizes the financial risks inherent in the real estate decision making process.

The principals and associates of the firm have been professionally trained, are experienced in Hawaiian real estate, and are actively associated with the Appraisal Institute and the Counselors of Real Estate, nationally recognized real estate appraisal and counseling organizations.

The real estate appraisals prepared by The Hallstrom Group accomplish a variety of needs and function to provide professional value opinions for such purposes as mortgage loans, investment decisions, lease negotiations and arbitrations, condemnations, assessment appeals, and the formation of policy decisions. Valuation assignments cover a spectrum of property types including existing and proposed resort and residential developments, industrial properties, high-rise office buildings and condominiums, shopping centers, subdivisions, apartments, residential leased fee conversions, special purpose properties, and vacant acreage, as well as property assemblages and portfolio reviews.

Market studies are research-intensive, analytical tools oriented to provide insight into investment opportunities and development challenges, and range in focus from highest and best use determinations for a specific site or improved property, to an evaluation of multiple (present and future) demand and supply characteristics for long-term, mixed-use projects. Market studies are commissioned for a variety of purposes where timely market information, insightful trends analyses, and perceptive conceptual conclusions or recommendations are critical. Uses include the formation of development strategies, bases for capital commitment decisions, evidence of appropriateness for state and county land use classification petitions, fiscal and social impact evaluations, and the identification of alternative economic use/conversion opportunities.

ARBITRATION
VALUATION AND
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PROFESSIONAL QUALIFICATIONS OF JAMES E. HALLSTROM, JR., MAI, CRE

Business Background	President	The Hallstrom Group, Inc. Honolulu, Hawaii (1980 - Present)
	Former Senior Vice President and Treasurer	Hastings, Martin, Hallstrom and Chew, Ltd., Honolulu, Hawaii (1972-1980)
	Former Real Property Appraiser and Analyst	Administration, Inc., a subsidiary of C. Brewer and Company, Limited Honolulu, Hawaii (1971-1972)
	Former Senior Real Property Appraiser and Analyst	Opitz Realty, Madison, Wisconsin (1969-1971)

National Designations and Memberships

- CRE Designation (1998) - The Counselors of Real Estate
- MAI Designation (1976) - American Institute of Real Estate Appraisers
- SRPA Designation (1975) - Society of Real Estate Appraisers

The American Institute of Real Estate Appraisers (AIREA) and the Society of Real Estate Appraisers (SREA) consolidated in 1991, forming the Appraisal Institute (AI).

Education

- M.S. (Real Estate Appraisal and Investment Analysis) 1971, University of Wisconsin at Madison
- B.A. (Economics) 1969, Brigham Young University at Provo
- Additional numerous specialized real estate studies in connection with qualifying for national professional designations, and uninterrupted Continuing Education.
- Completed Continuing Education requirements with the Appraisal Institute through 2006.

Professional Involvement

- Former President and Officer for Hawaii AIREA and SREA Chapters
- Instructor for Society of Real Estate Appraisers Course 101, "Introduction to Appraising Real Property" and Course 201, "Principles of Income Property Appraising"
- Contributing author to the "Hawaii Real Estate Investor"
- Lecturer at many professional seminars and clinics.
- Appointed numerous times as an Arbitrator and Mediator.

Qualified Expert Witness

Federal and State Courts
State Land Use and County Hearings
Arbitration Proceedings

State of Hawaii Certification

Certified General Appraiser, License Number CGA-178, Exp. Date December 31, 2005

Community Service

Active registered member of the Boy Scouts of America; former Director of Le Jardin Academy; former Advisory Board Member of the School of Business, Brigham Young University, Hawaii Campus; Director of Hawaii Reserves, Inc.

PROFESSIONAL QUALIFICATIONS OF THOMAS W. HOLLIDAY

Business Background

Supervisor/ Senior Analyst — The Hallstrom Group, Inc. Honolulu, Hawaii

Former Staff Appraiser — Davis-Baker Appraisal Co. Avalon, Santa Catalina Island, California

Education

- B.A. (Communications/Journalism) 1978 California State University at Fullerton
- SREA Course 201- Principles of Income Property Appraising
- Expert witness testimony before State of Hawaii Land Use Commission and various state and county boards and agencies since 1983.
- Numerous professional seminars and clinics
- Contributing author to Hawaii Real Estate Investor, Honolulu Star Bulletin

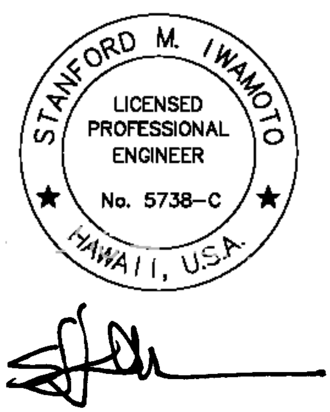
On January 1, 1991, the American Institute of Real Estate Appraisers (AIREA) and the Society of Real Estate Appraisers (SREA) consolidated, forming the Appraisal Institute (AI).

Recent Maui Assignments (since 2000)

- Market Study, Economic Impact Analyses and Public Costs/Benefits Assessments
  -- Wailea Ranch (Master Planned Community)
  -- Palauea Bay (Resort/Residential)
  -- Upcountry Town Center (Mixed-Use Planned Development)
  -- Maui Lani (Residential and Industrial Components of Master Planned Community)
  -- Maui Business Park, Phase II (Industrial/Commercial)
  -- Four Seasons Private Estates and Residences Club (Resort/Residential)
  -- Kualono Subdivision (Residential)
  -- Kapalua Mauka (Master Planned Community)
  -- Hailiimailii (Commercial)
- Major Valuation Assignments
  -- Sheraton Maui Hotel
  -- Outrigger Wailea Resort Hotel
  -- Maui Lu Hotel
  -- Coconut Grove Condominiums
  -- Palauea Bay Holdings
  -- Wailea Ranch
  -- Maui Coast Hotel
  -- Westin Maui Hotel
  -- Maui Marriott Hotel
  -- Waihee Beach

Appendix P

VILLAGE AT PO‘IPŪ
PRELIMINARY ENGINEERING REPORT
August 15, 2005
November 25, 2005 (rev)



This report was prepared
By me or under my supervision
License Expires April 30, 2006

Kodani and Associates, Inc.
3126 Akahi Street
Līhu‘e, Kaua‘i, Hawai‘i

**VILLAGE AT PO'IPU
PRELIMINARY ENGINEERING REPORT**

The Village at Po‘ipū is located on the south side of the island of Kauai in the resort community of Po‘ipū. The TMK parcels that are included in this development are: 2-8-13: 01 and 2-8-14: 01-04, 19, and 37. The parcels stretch from Po‘ipū Road on the south (Mauka of the Po‘ipū Shopping Village and the Kiahuna Tennis Club) to Weliweli Road on the north. Kiahuna Plantation Drive and Hapa Road run along its western side and the Weliweli Houselots Subdivision and a State of Hawai‘i parcel flank the property on the east. The development covers approximately 203 acres. Figure No. 1 shows the location of the project site in Po‘ipū.

The land is currently used as pasture land for cattle. A master plan for the development of this area has been completed and is shown in Figure No. 2. The master plan calls for the development of approximately 503 dwelling units on lots with zoning varying from open to R-10.

This Preliminary Engineering Report (PER) is being prepared in conjunction with the Environmental Impact Statement for the development the Village of Po‘ipū. The PER will discuss overall infrastructure requirements for storm drainage, water, and wastewater at the master plan level of detail.

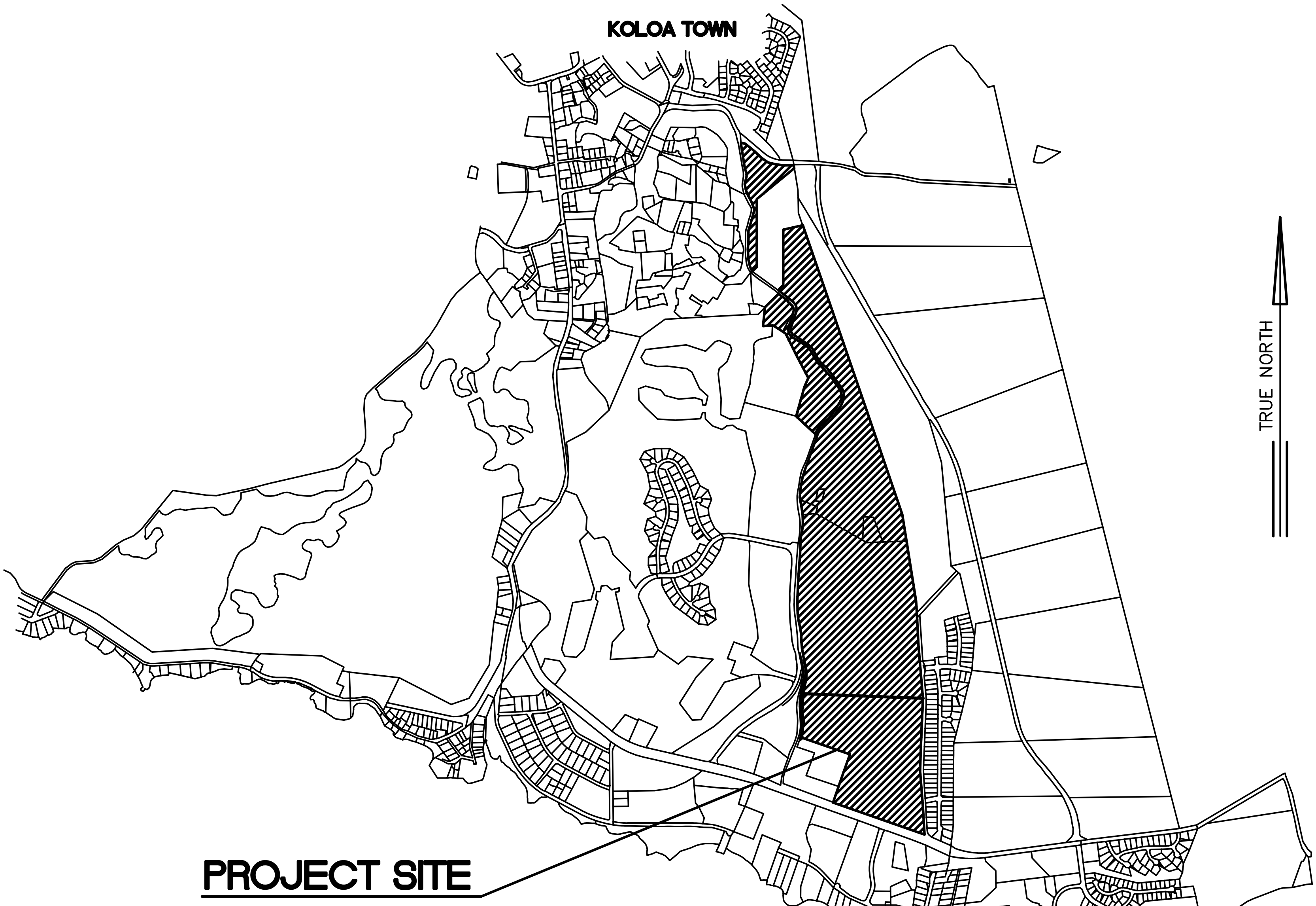


FIGURE NO. 1
LOCATION MAP

nts

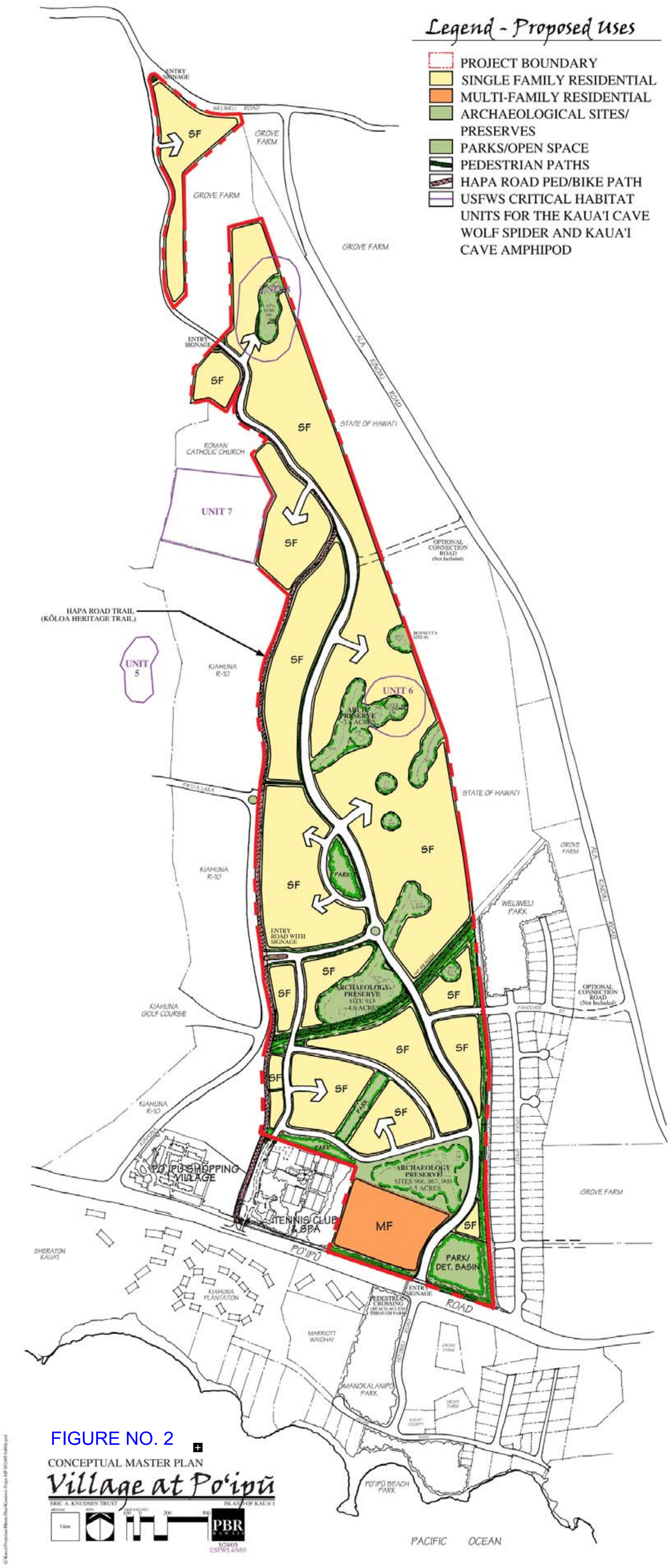

Legend - Proposed Uses
PROJECT BOUNDARY
SINGLE FAMILY RESIDENTIAL
MULTI-FAMILY RESIDENTIAL
ARCHAEOLOGICAL SITES/ PRESERVES
PARKS/OPEN SPACE
PEDESTRIAN PATHS
HAPA ROAD PED/BIKE PATH
USFWS CRITICAL HABITAT UNITS FOR THE KAUA'I CAVE WOLF SPIDER AND KAUA'I CAVE AMPHIPOD
ENTRY SIGNAGE
WELIWELI ROAD
SF
GROVE FARM
ALA KINOIKI ROAD
STATE OF HAWAI'I
ROMAN CATHOLIC CHURCH
UNIT 7
OPTIONAL CONNECTION ROAD (Not Included)
HAPA ROAD TRAIL (KŌLOA HERITAGE TRAIL)
UNIT 5
KIAHUNA R-10
UNIT 6
ARCH PRESERVE
PARK
ENTRY ROAD WITH SIGNAGE
WELIWELI PARK
ARCHAEOLOGY PRESERVE SITE 913 4.6 ACRES
KIAHUNA GOLF COURSE
PO'IPU SHOPPING VILLAGE
ARCHAEOLOGY PRESERVE SITES 966, 967, 900 5.5 ACRES
TENNIS CLUB & SPA
MF
PARK/ DET. BASIN
PO'IPŪ ROAD
SHERATON KAUA'I
KIAHUNA PLANTATION
PEDESTRIAN CROSSING
MARRIOTT WAIOHAI
MANOKALANIPO PARK
PO'IPŪ BEACH PARK
PACIFIC OCEAN
CONCEPTUAL MASTER PLAN
Village at Po'ipū
ERIC A. KNUDSEN TRUST
ISLAND OF KAUA'I
PBR HAWAII
USFWS 4/9/03

FIGURE NO. 2

STORM DRAINAGE

The development of the Village at Po‘ipū will result in the construction of buildings, roads and other impervious areas that will generate additional runoff from the project site. This section of the PER will describe the existing drainage conditions, estimate the changes in drainage conditions due to the development of the Village at Po‘ipū, and then describe and evaluate the proposed facilities needed to conform to the requirements of the County of Kaua‘i's Stormwater Runoff System Manual.

EXISTING CONDITIONS. The project site can be divided into four drainage areas as shown in Figure No. 3, Existing Drainage Area Map. Drainage Area No. 1 covers about 50.8 acres and is located between an abandoned railroad berm and Po‘ipū Road. Runoff flows south toward a series of five 66" corrugated metal culverts that cross Po‘ipū Road east of its intersection with Hapa Road. Downstream of Po‘ipū Road the runoff flows through a gully on the Kiahuna Plantation property before flowing through the Waiohai Hotel property to the ocean.

Drainage Area No. 2 is about 73.7 acres and is located east of Drainage Area No. 1. Runoff flows south toward the intersection of Po‘ipū Road and Kipuka Street. A single 48-inch culvert crosses Po‘ipū Road in this area. The runoff will flow through the Po‘ipū Beach Park area before it reaches the ocean.

Drainage Area No. 3 is the area directly north (mauka) and adjacent to the railroad berm. Runoff from about 130.6 acres flows south to the railroad berm then west along the berm until it can flow around the berm near Hapa Road. Runoff from this drainage area will combine with the runoff from Drainage Area No. 1 as it flows to five 66-inch culverts described above.

Drainage Area No. 4 is located at the northern part of the project site. Runoff from this 42.6-acre area flows to the Kiahuna Golf course. This runoff makes its way through the golf course before crossing Po‘ipū Road on the way to the ocean.

The project site is currently used as pasture land for cattle. The land can be described as rocky and dry with weeds and brush being the primary vegetation found onsite. Soils are classified as Waikomo soils, a type "D" soil.

Hydrological Methodology. The Quick TR-55 computer program was used to determine the peak discharges from the area of the proposed subdivision for the 100-year 24-hour storm under both the existing and developed conditions. The

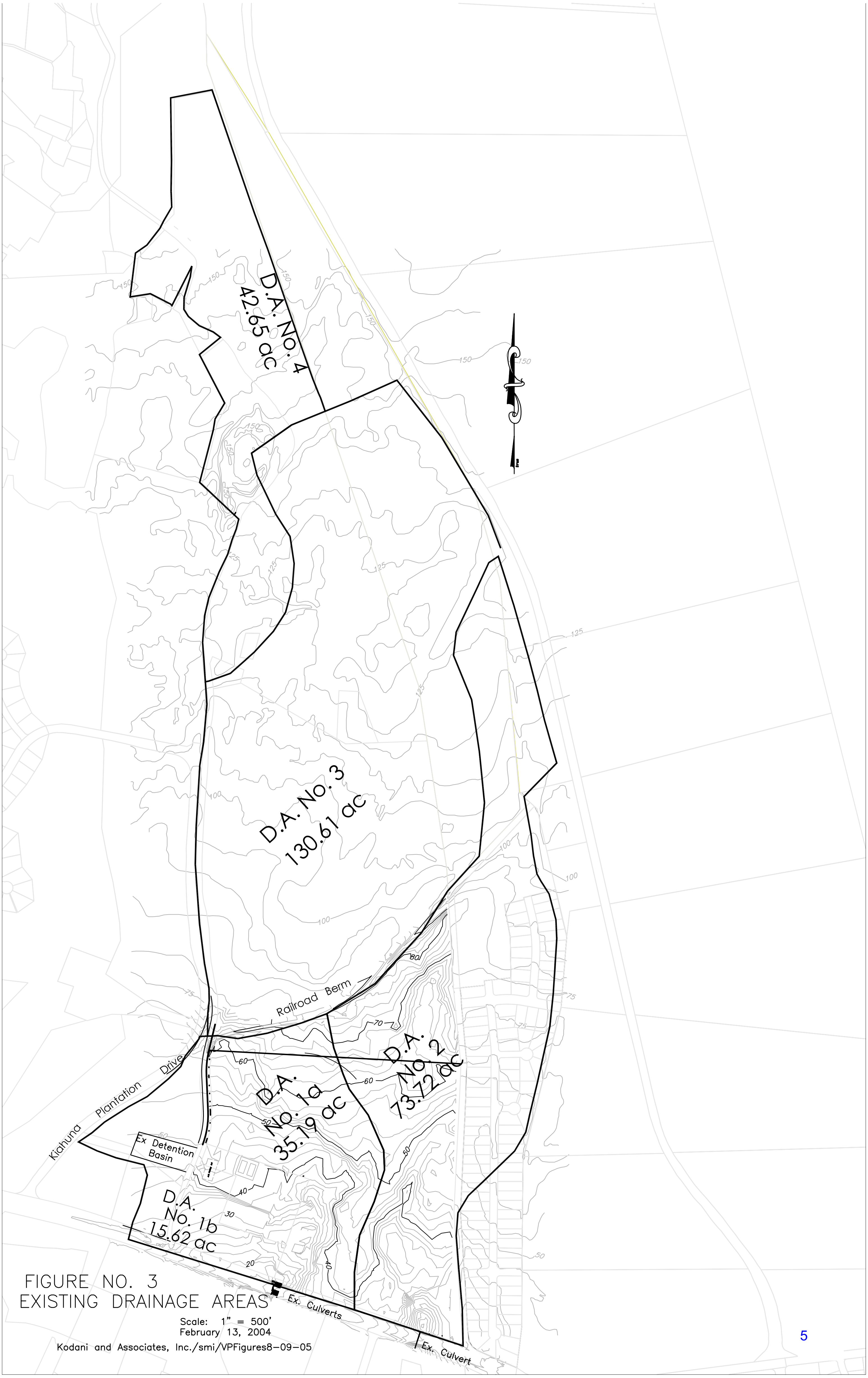


FIGURE NO. 3
EXISTING DRAINAGE AREAS

Scale: 1" = 500'
February 13, 2004
Kodani and Associates, Inc./smi/VPFigures8-09-05

100-year 24-hour storm is considered the base storm for flood calculations. The Quick TR-55 computer program is based on the Soil Conservation Services Tabular Hydrograph Method as outlined in its Technical Release No. 55 "Urban Hydrology for Small Watersheds".

Peak Discharge Rates. Drainage Areas Nos. 1 and 3 were combined and a peak discharge rate was calculated for this total area since the runoff from these two areas combine before flowing through the series of five culverts crossing Poʻipū Road.

TABLE NO. 1
EXISTING CONDITIONS, PEAK DISCHARGE RATES

Drainage Area	Area (acres)	Peak Discharge Rate (cfs)
No. 2	73.7	277
No. 1 and 3	181.42	519
No. 4	42.65	170

FUTURE CONDITIONS. The development of the Village at Poʻipū will result in the construction of buildings, roads and other impervious areas that will generate additional runoff from the project site. Figure No. 4 shows the drainage areas with the development completed. Drainage patterns and areas will change slightly from the existing conditions as the runoff pattern is revised to follow the new roadways.

The peak discharge rates for the 100-year 24-hour storm were calculated using the TR-55 method and are shown in Table No. 2.

TABLE NO. 2
FUTURE CONDITIONS, PEAK DISCHARGE RATES

Drainage Area	Area (acres)	Peak Discharge Rate (cfs)
No. 2	93.05	332
No. 1 and 3	165.84	466
No. 4	38.9	157

Detention Facilities. The County of Kauaʻi requires that for new developments, the peak discharge rate for the future condition be maintained at existing levels. To meet this requirement, the developer proposes to construct detention basins

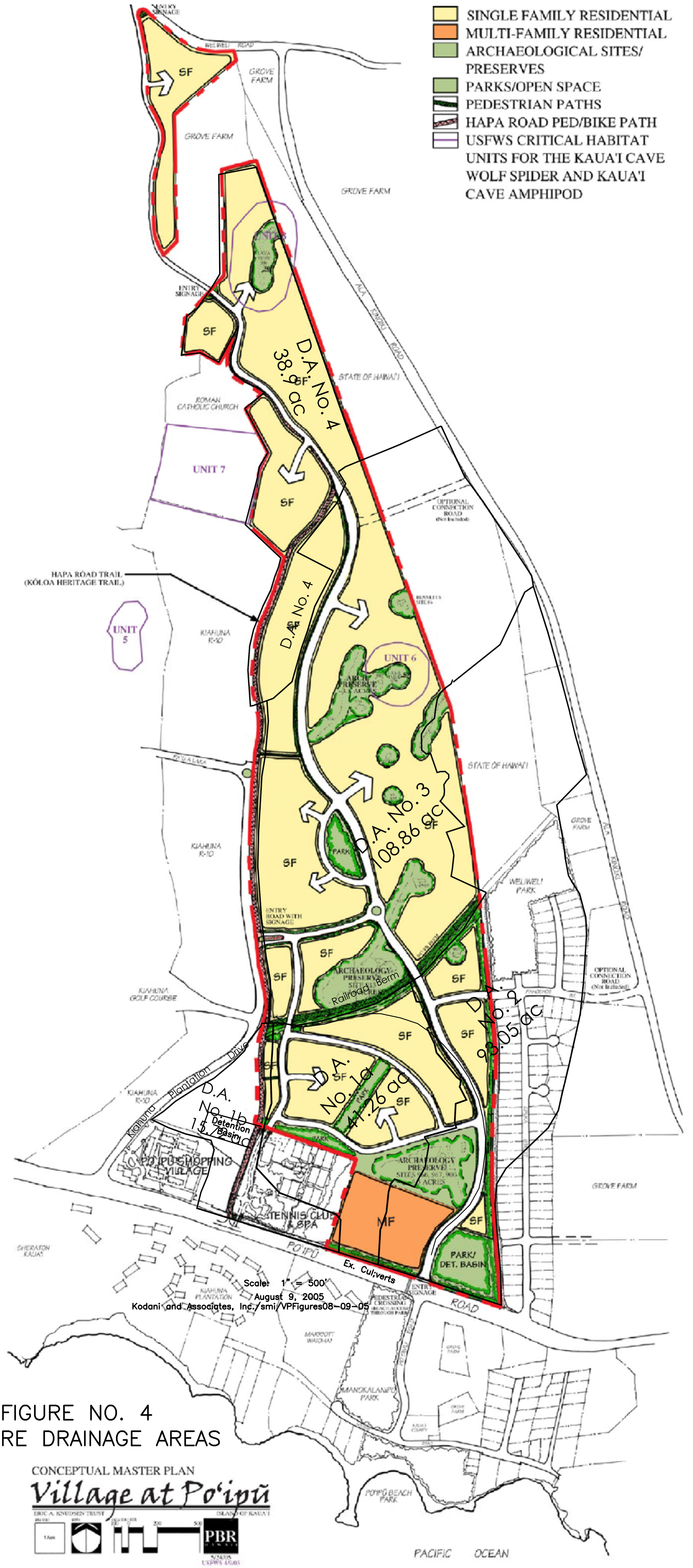


FIGURE NO. 4
FUTURE DRAINAGE AREAS

near Po‘ipū Road. Table No. 3 compares the existing peak discharge rates with the peak discharge detention rates (after detention).

TABLE NO. 3
FUTURE CONDITIONS, PEAK DISCHARGE RATES

Drainage Area	Existing Peak Discharge Rate (cfs)	Future Peak Discharge Rate (cfs)	Future Peak Discharge Rate After Detention
No. 2	277	332	172
No. 1 and 3	519	466	No Detention
No. 4	170	157	No Detention

Drainage Area No. 2. This drainage area is located along the east side of the project site and flows to a culvert near the intersection of Po‘ipū Road and Kipuka Street. The peak discharge rate for this area at full development will be about 332 cfs which is 55 cfs more than the existing peak discharge rate of 277 cfs. Please note that for Drainage Area No. 2, the existing gully area directly upstream of the culvert crossing is not large enough to act as a detention basin. To maintain the pre-development peak discharge rate, the gully area upstream of the culvert will need to be expanded to provide additional storage space. Presently, runoff from larger storms ponds upstream of the 48” culvert in this gully area before flowing through the culvert. To provide additional storage space, this gully area needs to be expanded to provide 14.4 acre-feet of storage at a water depth of about 10 feet. The detention facility will be part of a 4.6-acre park/open area that should be fenced so it can be secured during heavy runoff conditions for safety. This detention facility will be constructed as part of the Phase II improvements and will be designed with bio swales designed with native plant material to retard flow and encourage pollutants to settle, enhance infiltration, and clean rainwater runoff. The peak discharge rate will be reduced by about 100 cfs compared with existing conditions.

Drainage Area No. 1 and 3. Storm runoff generated by these two drainage areas combine together before flowing under Po‘ipū Road through the existing five 66-inch culverts. Although the peak discharge will normally increase when a project site is developed, the peak discharge rate was calculated to decrease by 53 cfs from 519 cfs to 466 cfs after construction in this area is completed. The lack of a significant increase in the peak discharge rate can be attributed to a decrease in the size of the drainage basin due to the construction of roads which alter the drainage pattern. Since the peak discharge rate for these two drainage areas does not increase, no detention facilities are required.

Drainage Area No. 4. Peak discharge rates from this drainage area will also decrease as portions of this drainage area become included with Drainage Area No. 3. The peak discharge rate of 170 cfs will decrease to 157 cfs as the drainage area decreases by 2.8 acres. No detention facilities are planned.

TEMPORARY DETENTION BASIN. The Village at Poipu is scheduled to be developed in phases, with the areas below or makai of the railroad berm being developed first and areas further mauka being developed later. The phasing of the development would require the construction of a temporary detention basin to dampen peak discharge rates generated by development of the area below the railroad berm.

To estimate the size of the detention basins, Drainage Area No. 1 was further divided into two sub-drainage areas, 1a and 1b, with Drainage Area No. 1a containing those areas that are being developed as part of the Village at Po‘ipū. The peak discharge rate for Drainage Area No. 1a was then used in determining the detention basin requirements for that area. The peak discharge rate for this area at full development will be about 230 cfs which is 59cfs more than the existing peak discharge rate of 171 cfs. To maintain the pre-development peak discharge rate, a detention facility will be constructed upstream of the culvert openings at Po‘ipū Road as shown on Figure No. 5. The basin shown on Figure No. 5 will lower the peak discharge rate to 170.2 cfs and have a storage volume of 5.2-acre feet at a water depth of about 2.2 feet. The temporary detention basin is included in the Phase I construction plans.

As noted above, the peak discharge for the future condition of Drainage Areas Nos. 1 and 3 is lower than the existing peak discharge from these drainage areas. Therefore, when Drainage Areas Nos. 1 and 3 are completely developed and the permanent detention facility is constructed, the temporary detention facility could be removed.

LOCAL DRAINAGE SYSTEM. Plans to effectively manage storm runoff from frequent storm events should be a part of any planned community. The Village at Po‘ipū will control runoff from common storm events with a local drainage system consisting of drain inlets, bioswales, manholes, drain pipes and outlet structures built along the roadways of its development.

FIGURE NO. 5
DETENTION BASIN MAP
Scale: 1" = 200'
August 09, 2005
Kodani and Associates, Inc./smi/vp8-09-05

The calculation of storm runoff quantities for the Village at Poʻipū was based on the Storm Water Runoff System Manual (hereinafter referred to as the "Manual") of the Department of Public Works, County of Kauaʻi, dated July 2001. As specified in the Manual, the rational method was used for computing flow rates for the 2-year and 100-year storms. Rainfall intensities for the 2-year and 100-year storms were obtained from Plates 3 and 4 of the Manual and found to be 1.7 inches and 3.4 inches, respectively.

Runoff coefficients used to calculate the peak discharge rate were obtained from Table 1 of the Manual and are listed in the Table below.

Table No. 4
Runoff Coefficients

Drainage Manual Land Use Characteristics	Master Plan Description	2-year "C"	100-year "C"
R-2	1-acre lots or larger	0.38	0.55
R-4	6,000 sf lots	0.43	0.70
R-6	5,000 sf lots	0.50	0.80
Road Right of Way		0.55	0.92
Parks, Archaeological Uses		0.38	0.55

For areas designated for park or archaeological preservation, coefficients for the 2-year and 100-year storm were selected to be 0.38 and 0.55, respectively. These coefficients are more conservative (higher) than the factors shown in Table 4 and reflect the rocky nature of the existing land. A "C" of 0.50 (R-6) was assigned to offsite areas.

The Drainage Master Plan for this project and is shown in Figure No. 6. There are five local drainage systems located along the roadways of the development. Drainage Systems 1a, 1b, and 1c collect and route runoff to Detention Basin No. 1. Drainage System No. 4 discharges to a swale leading to Detention Basin No. 2. Drainage Systems Nos. 2 and 3 serve the mauka areas of the development and discharge towards the Kiahuna Golf Course. Each of the drainage systems serves a drainage basin less than 100 acres in size and the runoff generated to each drain inlet was calculated using the Rational Method with the 2-year storm. Pipe sizes were estimated assuming that flows are inlet controlled with a ratio of headwater to pipe diameter of 1.5.

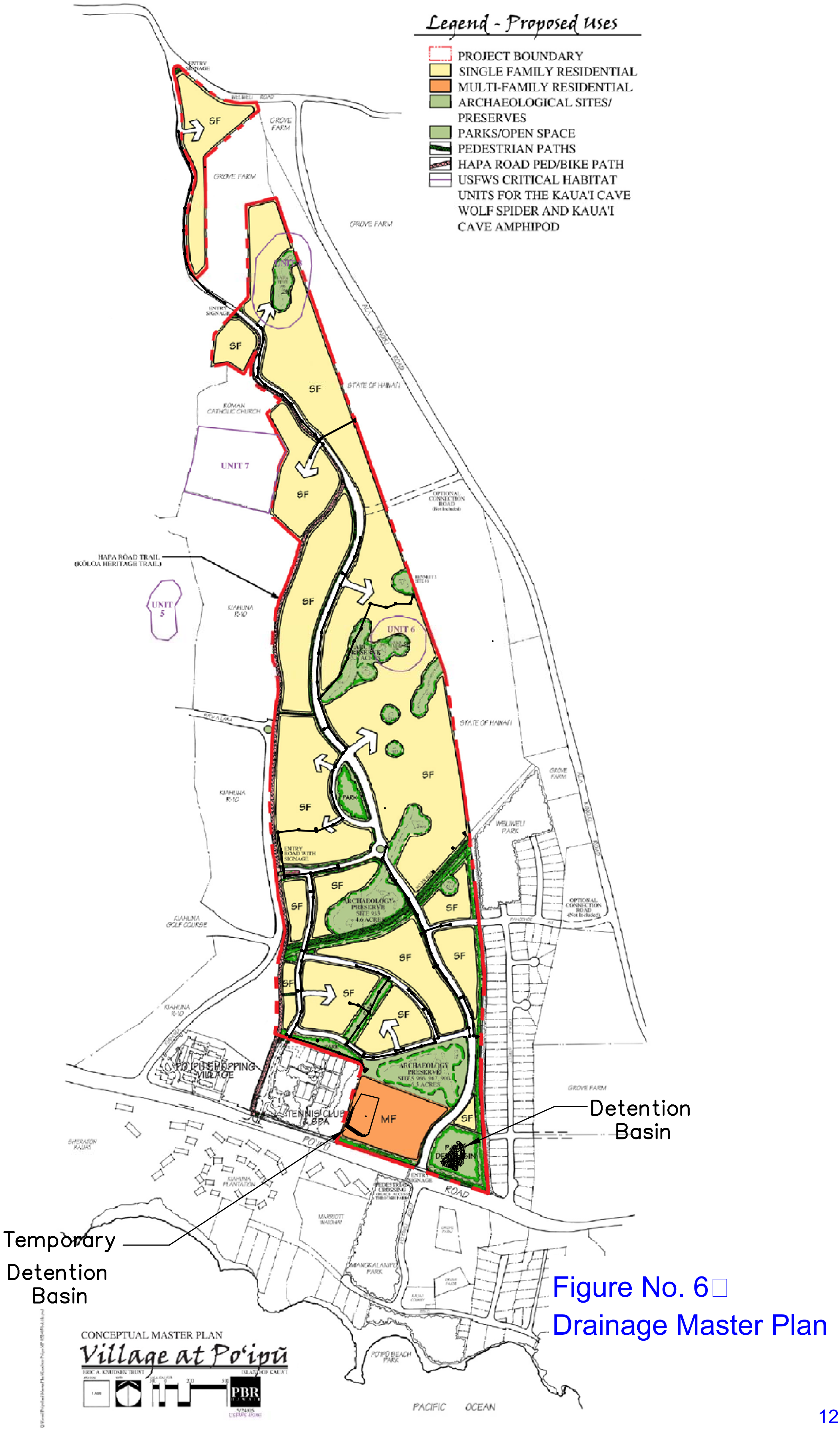


Figure No. 6
Drainage Master Plan

IMPACT OF THE DEVELOPMENT. The development of the Village at Poʻipū will result an increase in the runoff rate from the project site. However, detention basins will be incorporated into the design of the project to ensure that peak discharge rates do not exceed the discharge rates currently experienced. In fact, runoff is reduced based on the proposed improvements. Therefore the development will not create an unreasonable risk to adjacent and downstream properties. Furthermore, the use of bioswales and biofiltration should help slow runoff and improve water quality of the runoff.

WATER SYSTEMS

Potable water for use by the residential units in the Village at Poʻipū development will be supplied by the County of Kauai's Department of Water (DOW). The water facilities will be built to DOW standards and will be dedicated to the DOW prior to connection.

Non-potable irrigation water for use on landscaped areas in common areas, the multi-family developments, and larger single-family lots may be supplied by a private system operated by the developer and transferred to an owner's association.

POTABLE WATER DEMAND. The Village at Poʻipū is located within the DOW's Koloa- Poʻipū Water System. The service area of this system consists of a concentration of resorts along the Poʻipū coastline and residential communities clustered near the coast and around Koloa town. The Koloa Poʻipū Water System is divided into a 366-foot pressure zone and a 245-foot pressure zone and is currently supplied by five wells with a total capacity of about 3560 gpm. Total available storage for the water system is 4.25 million gallons. Figure No. 7, Water Distribution System, shows which areas of the development would be served by the 245-foot service zone and which areas would be served by the 366-foot service zone.

Water demand was calculated based on the DOW water standard of an average demand of 500 gallons per unit per day for single family residences and an average demand of 350 gallons per unit per day for multi-family residences. Table No. 5, Water Demand, summarizes the water demand requirements for the proposed development.

TABLE NO. 5
WATER DEMAND

Type of Residential Units	No of Units	Per Unit Demand (gallons per day)	Average Daily Demand (gallons)	Maximum Daily Demand (gallons)
245-Service Zone				
Single Family	211	500	105,500	158,250
Multi-Family	134	350	46,900	70,350
Total 245-zone	345		152,400	228,600
366-Service Zone				
Single Family	158	500	79,000	118,500
Total Both Zones	503		231,400	347,100

POTABLE WATER SOURCES. Within the 245-foot service zone, the DOW has agreed to supply water from its existing sources to the 50 single-family units that make up Phase 1 of the Village at Po‘ipū. Water for the remainder of the development within the 245-foot service zone will become available when Well “F” is completed. The Village at Po‘ipū proposes to meet its source requirements by entering into an agreement with the DOW to pay a pro-rata share of the total cost to develop and outfit Well “F”.

The development of the units within the 366-foot service zone is not expected to begin until about 2015. At that time it is expected that additional sources will have been developed by the DOW and the water from those sources can be used by the Village at Poipu.

WATER RESERVOIR STORAGE. The DOW, like it has agreed to do with water sources, will provide storage for the 50 single-family units that make up Phase 1 of the Village at Po‘ipū from its existing water tanks. Water storage requirements are based on the maximum daily demand of a project and within the remainder of the development within the 245-foot service zone should be available when the DOW’s second 1,500,000-gallon storage tank is completed. Fifty percent of the storage volume in this tank is reserved for future developments within this service zone including the Village at Po‘ipū.

The maximum daily demand for units in the 366-foot service zone was estimated to be about 118,500 gallons per day. Currently storage capacity to serve these units is not available and the developer may have to construct and dedicate a new storage tank to the DOW to meet this requirement.

TRANSMISSION AND DISTRIBUTION REQUIREMENTS. Figure No. 7 shows the location of existing water mains adjacent to or within the project site. The existing DOW 18” transmission main that runs through the project site and the mains along Kiahuna Plantation Drive and Po‘ipū Road have sufficient capacity to serve the projects within the 245-foot service zone.

Transmission lines serving the 366-foot service zone will not be required until approximately 2015. At that time it is expected that new DOW transmission lines or transmission lines installed by neighboring developments will have sufficient capacity to serve the 366-foot service zone of this project.

Distribution lines within the project site will range from 2.5 inches to 12 inches. These lines will be located within the roadways. Figure No. 7 shows the layout of the water distribution system for the Village of Poipu. Figure 8 is the DOW’s Water System Map for Po‘ipū.

NON-POTABLE WATER. To reduce the amount of potable water required by the development, the Village at Po‘ipū will have a private non-potable system to irrigate common areas, larger single-family lots, and the multi-family lots. The total peak season non-potable supply requirement was estimated to be 0.56 mgd. The non-potable water would be supplied by Grove Farm Land Company’s Waita reservoir or on-site wells.

FIGURE 7
WATER DISTRIBUTION SYSTEM

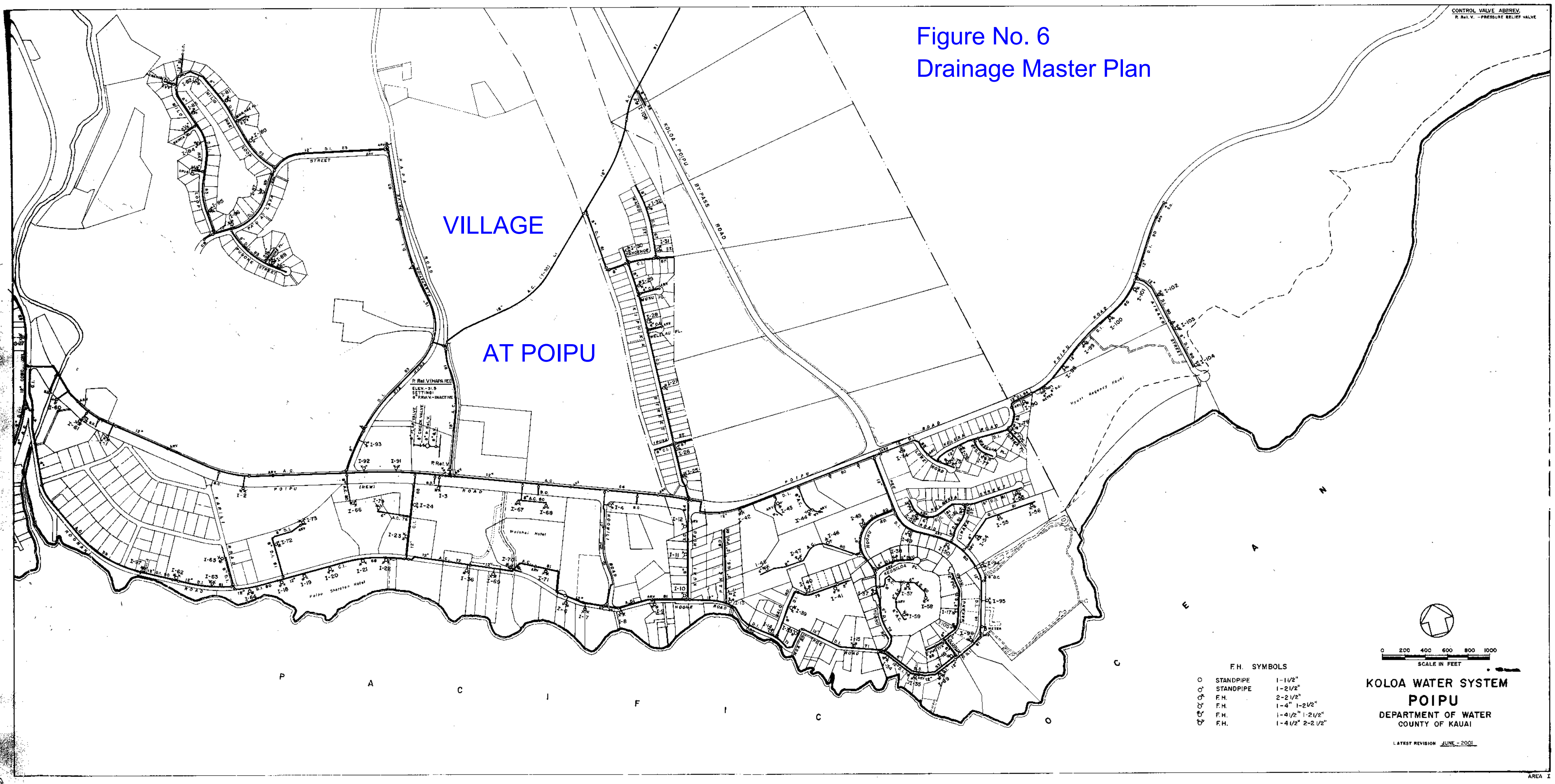


Figure No. 6
Drainage Master Plan

WASTEWATER

Wastewater generated by the Village at Poipu project would be collected then routed to the Poʻipū Water Reclamation Facility for treatment before disposal. The treatment plant is a privately owned secondary treatment plant whose effluent is used to irrigate the adjacent Kiahuna Golf Course. An upgrade and expansion of the wastewater plant was initiated in 2004. The first phase of improvements has been completed and included a new biological process, capable of treating up to 1,000,000 gallons per day of wastewater. With the completion of this phase, the Poʻipū Water Reclamation Facility has sufficient capacity to treat all the wastewater that will be generated by the Village at Poʻipū.

The second phase of improvements at the treatment plant is estimated for completion at the end of 2005 and includes tertiary filtration and ultraviolet (UV) disinfection. When the second phase of improvements is completed, the treatment plant will meet R-1 standards, which is the highest level of effluent quality regulated by the State of Hawaii.

WASTEWATER GENERATION. Wastewater generation rates were estimated to be about 181,000 gallons per day based on Kauai County standards and are presented in Table No. 6, below.

TABLE NO. 6
WASTEWATER GENERATION

Type of Residential Units	No of Units	Per Unit Demand (gallons per day)	Average Daily Demand (gallons)
245-Service Zone			
Single Family	211	400	84,400
Multi-Family	134	250	33,500
Total 245-zone	345		117,900
366-Service Zone			
Single Family	158	400	63,200
Total Both Zones	503		181,100

A sewer collection system consisting of sewer manholes and 8-inch sewer pipelines will be constructed on the Village at Poʻipū. Also to be constructed are sewer pump stations and off site sewer mains. Figure No. 9 shows a proposed layout of the wastewater collection system.

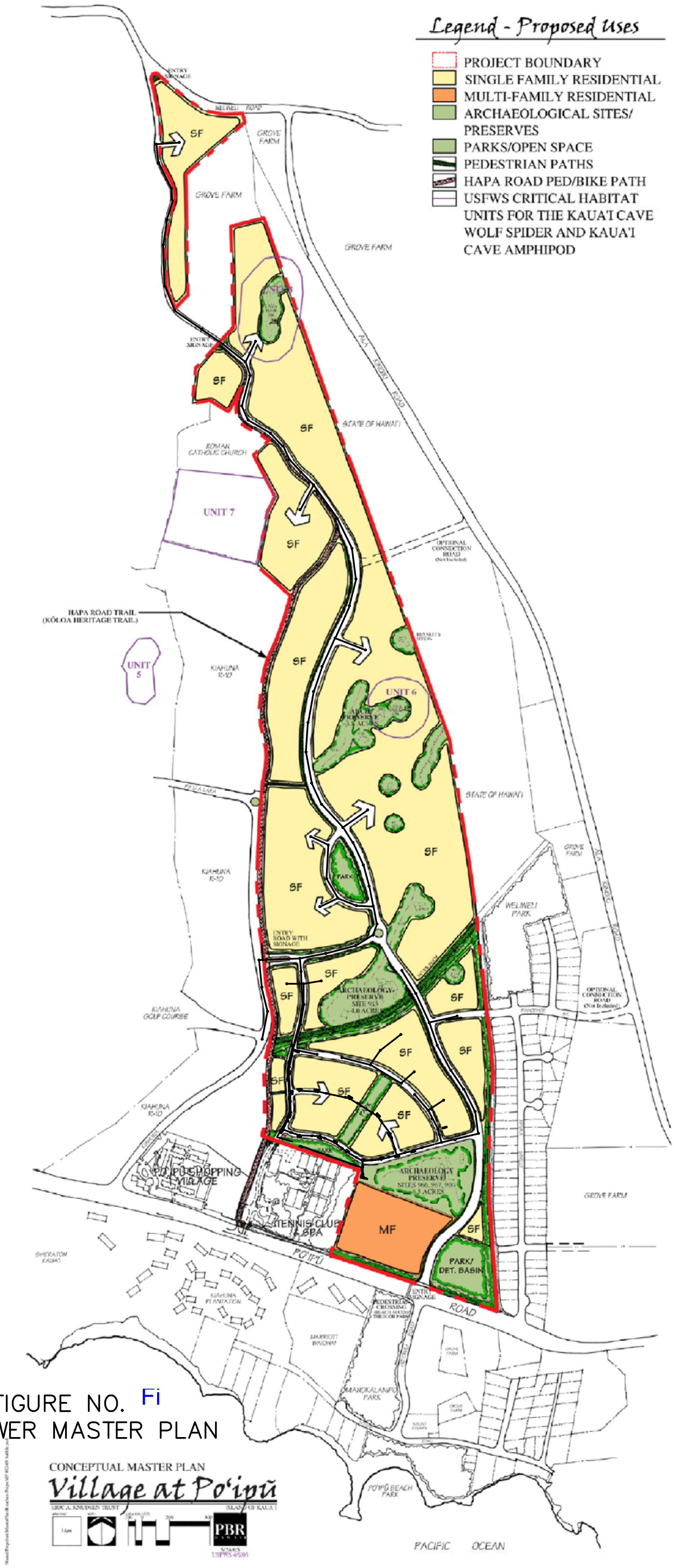


FIGURE NO. Fi
SEWER MASTER PLAN