Draft Environmental Impact Statement

Kaloko Makai

Kaloko and Kohanaiki, North Kona, Island of Hawai‘i

Volume 2 of 2
Appendices A through S

Prepared For:
SCD-TSA Kaloko Makai, LLC

Prepared By:
Wilson Okamoto Corporation and
Ho‘okuleana LLC

July 2011

Draft
Environmental Impact Statement

Volume 2 of 2 – Appendices A through S

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July 2011

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Market Assessment for Kaloko Makai
Mikiko Corporation
May 2011

MIKIKO CORPORATION

MARKET ASSESSMENT FOR KALOKO MAKAI

North Kona, Island of Hawaii

Prepared for:
SCD-TSA Kaloko Makai, LLC

FINAL REPORT

May 2011

Market Assessment for Kaloko Makai

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Market Assessment for Kaloko Makai

Report Text

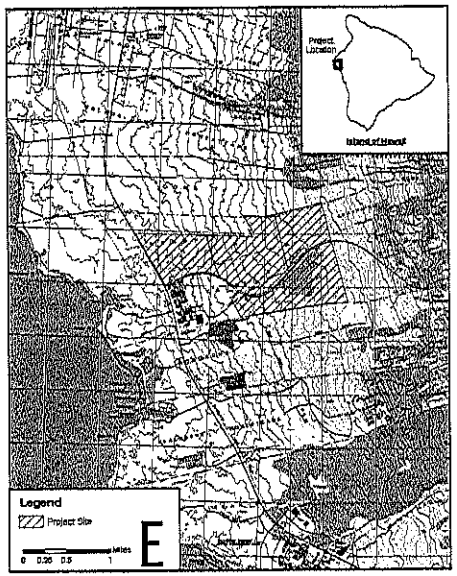
1 – Introduction and Executive Summary

Project Overview

Kaloko Makai Site and Location Characteristics (Exhibit 1-1)

SCD-TSA Kaloko Makai, LLC (SCD-TSA) proposes to develop a 1,142-acre site in North Kona, Hawaii, as a master-planned community called Kaloko Makai (the Project.) It is in a rapidly developing area, a few miles south of Kona International Airport at Keahole (Kona Airport) and adjacent to and north of the well-established commercial and light industrial-service centers of North Kona and Kailua-Kona.

Location and Vicinity of Kaloko Makai



Source: SCD-TSA Kaloko Makai, LLC, 2007.
See Exhibit 1-1 for copy at a larger scale.

The site ascends from Queen Ka'ahumanu Highway, to about two-thirds of the way *mauka* to Mamalahoa Highway. Its slope affords excellent ocean and regional views from most of the site.

Along Queen Ka'ahumanu Highway, Kaloko Makai extends from Huliko'a Drive to Hina Lani Street. At this *makai* edge, the site is bordered on the north by the Kohanaiki Industrial Park, and on the south by the Kaloko Industrial Park. Beyond that is the site of the planned West Hawaii Business Park. Also along its southern border on Hina Lani Street, the County is developing a 96-unit affordable project known as Kaloko Housing Project.

Across the highway are The Shores at Kohanaiki, a private golf and luxury second home project now under development, and the Kaloko-Honokohau National Historical Park.

Alongside the *mauka* portions of the site, Kaloko Makai is bordered by residential uses including SCD-TSA's planned Kaloko Heights community, Kula Nei (single-family lots) and Kona View Estates.

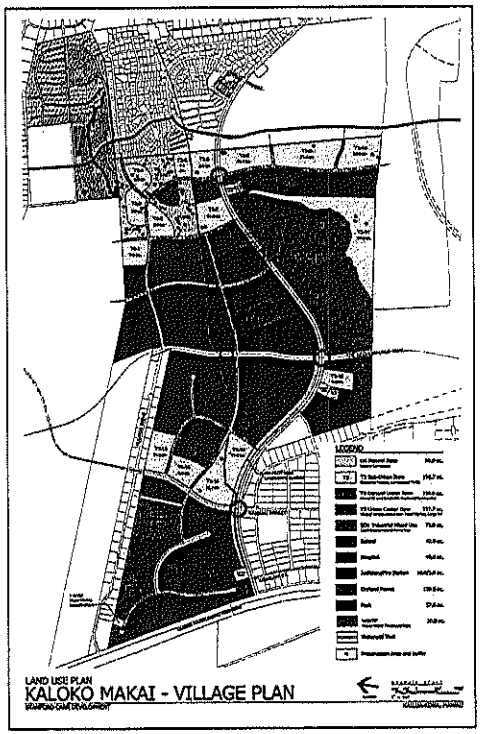
Meeting Community Desires (Exhibit 1-2)

Kaloko Makai has been planned to respond to its community's desires regarding future growth, as expressed in the Kona Community Development Plan.[1] The Kona CDP directed growth to compact, higher density "villages" mostly located north of Kailua-Kona Town along the Ane Keohokalole Highway transit corridor. These growth centers were directed to 10 Transit-Oriented Development (TOD) Urban Villages, of which Kaloko Makai is identified as one.

Kaloko Makai's plan supports many of the Guiding Principles of the Kona CDP:

- **Directs future growth patterns towards compact centers** – Kaloko Makai is planned around a compact urban center.

Kaloko Makai Land Use Plan



Source: SCD-TSA Kaloko Makai, LLC, 2011.
See Exhibit 1-2 for copy at a larger scale.

[1] Wilson Okamoto Corporation, for the County of Hawaii Planning Department, "Mapping Kona's Future: Kona Community Development Plan," September 2008.

- **Provides connectivity and transportation choices** – Kaloko Makai will be transit-ready and is located along key alignments for regional transportation. Developer SCD-TSA would also contribute to the development of Ane Keohokalole Highway. The Project itself is planned to offer walking and biking trails in addition to vehicular roads.

- **Provides housing choices** – Kaloko Makai would offer a broad range of housing types including affordable as well as "market-priced" housing units. Offerings would range from traditional single-family homes to mid- and higher-density multifamily homes, and may include live-work and mixed use developments.

- **Provides recreation opportunities** – Kaloko Makai features a 150-acre dryland forest preserve, as well as numerous community parks and trails.

- **Provides infrastructure and essential facilities concurrent with growth** – In addition to the recreational and transportation contributions noted above, Kaloko Makai is planned to include a hospital and medical complex, a judiciary center, two elementary schools, a middle school and a small lodge to accommodate visitors attracted by the other uses.

Kaloko Makai has also been planned to conform to the County of Hawaii's draft Kona Village Design Guidelines,[2] with its compact residential settings in a transit-ready, mixed-use community. As noted, the urban core of this community would be centered on the new "mid-level" Ane Keohokalole Highway, and residential densities and other specific development characteristics have been developed in conformance to the various "transect zones" define in the Design Guidelines.

Kaloko Makai Development Elements (Exhibit 1-2)

In addition to the schools, parks and trails, the Project's key development elements are:

- **Residential** – up to 5,000 residential units;

- **Commercial** – up to 1.1 million square feet of retail and office developments, including about 188,000 square feet within four planned medical office buildings;

- **Light industrial/ business park** - 75 acres, of which about 25 have been identified by the State Department of Transportation (DOT) as an area to be reserved for their proposed highway interchange at the main Project entrance on Queen Ka'ahumanu Highway[3]; and

[2] Place Makers, LLC, "Kona Village Design Guidelines" (calibrated for the County of Hawaii,) Final Draft, October 10, 2010.

[3] Therefore, long-term, there would be some 50 gross acres of light industrial/business park lands.

- **Lodge and Business Center** – up to 120-rooms at a kama'aina- and business-traveler oriented lodge with business support facilities and services.
- **Judiciary complex** – A new Kona courthouse and judiciary facilities is proposed for the State of Hawaii.
- **Medical complex** – A public hospital, outpatient care center and skilled nursing (SNF)/long-term care (LTC) facility are proposed.

Together, these developments would support a substantial civic and employment center, generating opportunities in professional, business, service and retail fields.

Study Background

SCD-TSA is working with Wilson Okamoto Corporation (Wilson Okamoto) to seek State of Hawaii (State) and County of Hawaii (County) entitlements for the Project, including a State Land Use District Boundary Amendment (SLUDBA), and County zoning. In this respect, SCD-TSA asked Mikiko Corporation (Mikiko) to prepare market, economic and fiscal impact assessments for the Project.

This report covers Mikiko's market assessment for the residential, commercial and light industrial/business park uses noted above. A specialized medical facilities expert, Cattaneo & Stroud, Ltd. has prepared the market assessment for the hospital/medical center. Their report is presented separately.

Mikiko's economic and fiscal impact assessment for the Project is also in a separate report.

Study Objective and Report Conditions (Appendix 6)

Mikiko's objective was to describe the market support for the residential, commercial, light industrial/business park and Lodge/Business Center uses proposed at Kaloko Makai, in terms of:

a) Evidence of the demand and competitive supply for each development element;

b) Assessment of market shares and/or supportable market absorption;

c) For residential units, assessment of supportable unit pricing; and

d) For the Lodge and Business Center, assessment of average daily room rates and occupancy.

Our evaluations are based in part on information and planning parameters provided by Wilson Okamoto and SCD-TSA.

The remaining sections of this chapter summarize the market conclusions. The rationale behind these conclusions, as well as documentation of the study methodology and supportive data, may be found in the subsequent chapters and appendices.

At the end of this report, Appendix 6 presents a statement of important report conditions.

Community Context and Need

Area Character

The North Kona area is appropriately seeing urban infill development and proposals, consistent with the 2008 Kona CDP and the 2010 draft Kona Village Design Guidelines noted above. To date, this development has concentrated along the major regional traffic corridor Queen Ka'ahumanu Highway, between the town of Kailua-Kona and the Kona Airport.

This rapidly developing area comprises the northwestern portion of the North Kona District, and is contained within Census Tract 215.01 (also referred to herein as "North Kona-North".)[4] It already is the commercial and industrial heart of West Hawaii, serving the Kona Airport and the needs of the visitor, agriculture, ranching, technology and other industries of the western half of the Island. The area also has a long-standing and growing residential base. This area will continue to be the focus of such development as the Island's population grows, given its proximity to the Kona Airport and other existing infrastructure.

Need for Residential Realignment and Development

Together with the coastal portion of the adjacent South Kohala District (CT 217.01, also referred to herein as "South Kohala-Waikoloa")[5], North Kona-North was estimated to provide 23% of the Island's employment in 2009.[6] However, as of 2010, this center of employment supported residences for only about 12% of the Island's population. This imbalance of jobs and housing leads to crowding among area households, and a tremendous amount of commuting into the region by persons who live in distant areas.

A relative lack of resident-oriented shopping, entertainment, and other services in the South Kohala-Waikoloa area also adds to traffic headed into the Kailua-Kona area from the north.

[4] See Appendix 1 for a map of this census tract.

[5] See Appendix 2 for a map of this census tract.

[6] Based on the estimated number of employees at establishments located in CTs 215.01 and 217.01 compared to total employees at all Island establishments, as of 2009, according to Claritas, Inc. Note that "employees" on the Island exceed the "civilian labor force," since labor force members may hold more than one job. The area's dominance of Island employment appears to be increasing: in 2006, this figure was 21% of Island employees.

Kaloko Makai is one of a relatively small group of area properties that could offer a substantial solution for this imbalance of primary resident-oriented housing, services, and the area's existing and anticipated jobs base.[7]

Kaloko Makai Residential Market

Need for Housing in the Area

The two census tracts 215.01 and 217.01 are considered Kaloko Makai's Competitive Regional Market Area (CRMA) for residential market conditions. It is considered possible and desirable that housing opportunities in the CRMA begin to approach the magnitude of employment opportunities. Thus, while current economic conditions have dampened actionable pent-up demand, the CRMA should be poised for a significant share of the Islands' anticipated future population growth, and this will lead to growing demand for homes in the region.

However, Mikiko's research concludes that even with aggressive and unprecedented levels of future development, the CRMA could experience a shortfall of some 9,400 primary homes by 2040, if no more lands are entitled and planned for this market.

Supply and Demand for New Resident Housing Units in the Competitive Regional Market Area, 2010 to 2040

Future Demand	Pent-up demand, 2010	0*
	Future need, 2011-2040	17,600
	Total need	17,600
Future Supply	Planned and entitled (8,800 less 5% vacancy), rounded	8,200
Shortage	**As of 2040**	**9,400**

* Assumed to be zero due to current economic environment.
Source: Mikiko Corporation, 2011. See Exhibit 3-5 for further information.

Residential Development Proposal

Kaloko Makai's plan features a transit-ready Urban Center (Transect zone T5) on Ane Keohokalole Highway, with lower density General Urban (T4) and Sub-Urban (T3) areas outlying. Based on the Kona Village Design Guidelines, the T4 and T5 areas would be predominantly multifamily (or high density single family within T4), while the T3 areas would include single-family residences. A Special/Mixed Use district in the lower portion of the site may also include some multifamily housing.

[7] While there are numerous area properties that seek to develop in the future, many are already designated Urban by the State, and therefore are already accounted for as future supply. See discussion immediately ensuing.

A conceptual maximum development scenario for the Project is as follows:

Conceptual Mix of Residential Units at Kaloko Makai
Maximum development at buildout

Predominant unit type	Transect zone	Total planned units	Example density (units per acre)
Multifamily ("affordable")	Special District and/or T5	700	13 to 17
Multifamily ("market")	T5	2,274	7 to 13
Multi- or single-family ("market")	T4	1,206	7 to 8
Single-family ("market")	T3	820	3 to 6
Total		**5,000**	**3 to 17**

Sources: Place Makers, LLC, 2010; SCD-TSA Kaloko Makai, LLC; Wilson Okamoto Corporation, 2011.

While some of the housing could be developed as rentals, residential market support is evaluated herein in terms of units offered for sale.

Residential Buyer Mix and Pricing

Considering the location, characteristics and types of residential developments proposed, about 85% of Kaloko Makai homes are anticipated to be used as primary homes, most for established Island residents.

Supportable pricing for the market-priced units is estimated as shown on the following table.

Market Unit Price Conclusions for Kaloko Makai
2010 dollars

	Average sales price*	Approximate average density (units/gross acre)
T3 – predominantly single-family	$475,000	3 to 6
T4 – small lot single-family and/or multifamily	$390,000	7 to 8
T5 – predominantly multifamily	$345,000	7 to 13
Overall, market homes	**$382,000**	**3 to 13**

* For market-priced units only.
Source: Mikiko Corporation, 2011. See Exhibit 4-2 for further information.

The production and pricing of affordable units at the Project would be set in accordance with County and/or State guidelines to be determined in consultation with government agencies. For illustrative purposes, the Project is expected to satisfy the required 1,000 affordable housing requirements with 700 for-sale housing units. The units would be priced with specific shares catering to households earning less than 80%, 80 to 100% and 100 to 120% of the County median income.[8]

Also according to County guidelines in effect as of September 1, 2010, conforming affordable housing prices for such housing could range from $202,500 to $366,200 for two-to four person households. The price guidelines also show one- to two-bedroom rental units priced from $1,037 to $1,500 per month, including utilities, and offered to households earning 80% to 100% of the median income.[9]

Projected Residential Sales Absorption

The first residential product at Kaloko Makai is projected to be available for sale in 2015. Thereafter, it is anticipated that the 5,000 maximum proposed homes could be absorbed over 26 years at an average rate of about 190 units per year.

[8] See Hawaii County Code, Chapter 11. If additional affordable housing is required in conjunction with other nonresidential developments proposed at Kaloko Makai, the developer would comply with the County Code.

[9] County of Hawaii, Office of Housing and Community Development, "Affordable Housing Guidelines for the County of Hawaii," 2010.

Illustrative Summary of Maximum Potential Residential Sales Absorption at Kaloko Makai, 2015 to 2040

	Affordable homes	Market homes	Maximum total housing
Maximum inventory	700	4,300	5,000
Average annual sales*	28	166	190 (rounded)

* Assumes several but not all products are marketed simultaneously in any given year. Thus, since market home sales may extend over a longer period than affordable home sales, the overall average rate is less than the sum of the two sub-market rates shown.
Source: Mikiko Corporation, 2011.

Actual sales would vary from year to year depending on market and construction cycles, and the types of units available for sale at any given time. At maximum buildout, Kaloko Makai's 5,000 units could provide a solution for about 45% of the anticipated future unplanned and unentitled demand for primary resident housing units (RHUs) in the CRMA through 2040[10].

Kaloko Makai Commercial Market

Primary Trade Area (see Exhibit 2-1)

The Primary Trade Area (PTA) for commercial uses at Kaloko Makai is considered to be the entire North Kona and South Kohala districts of the Island. This is a larger reference area than the CRMA considered in the residential market review, as explained in Chapter 5.

Commercial Development Proposal

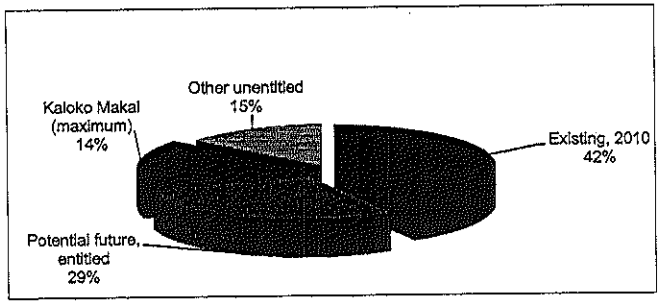
SCD-TSA proposes up to 1.1 million square feet of various commercial uses at Kaloko Makai, including retail and office. This would include spaces in shopping centers, restaurant and retail establishments, lawyers' offices, four proposed medical office buildings, other office complexes, and various mixed-use developments. As for residential development, the first finished commercial building products are assumed to be available for use in about 2015.

[10] Considering 85% of Kaloko Makai's units become used as primary residences, it could yield 4,250 RHUs, or 45% of the projected 9,400 RHU shortfall in 2040, based on currently entitled and planned residential lands.

Commercial Market Conclusions

If developed to the full-proposed capacity of 1.1 million square feet, Kaloko Makai's commercial spaces could represent some 14% of the PTA's total 2040 inventory. It could also represent a venue for about half of the currently unplanned but future supportable commercial space in the PTA.

Potential PTA Commercial Space Distribution and Fair Market Shares: 2040



Source: Mikiko Corporation, 2011. See Chapter 5 and Exhibit 5-8 for further information.

Development and lease-up of the proposed commercial areas are anticipated to be supported by future market conditions in the PTA as follows:

Projected Supportable Commercial Market Absorption and Kaloko Makai Share of the PTA
Cumulative gross leasable square feet

	2020	2030	2040
Kaloko Makai potential development phasing	500,000	900,000	1,100,000
Total supportable commercial areas in PTA	4,800,000	6,400,000	7,700,000
Kaloko Makai as share of future PTA	10%	14%	14%

Source: Mikiko Corporation, 2011. See Chapter 5 and Exhibits 5-7 and 5-8 for more information.

Kaloko Makai Light Industrial/Business Park Market

Primary Trade Area and Analytical Approach

Light industrial areas can support business parks, manufacturing, energy production, research & development, wholesale, office, retail and other uses. They often serve a super-regional or Island-wide market. This analysis profiles market trends within the North Kona and South Kohala Districts (the Primary Trade Area, or PTA.) However, the realized demand for such lands at Kaloko might be stronger than presented herein because it could derive from a larger market sphere.

This analysis does not consider industrial-uses or industrial-designated lands at military bases, harbors, universities or airports.

Light Industrial/Business Park Development Proposal

The Kaloko Makai plan designates 75 acres of light industrial or business park land uses in the Special District located at its makai end fronting Queen Ka'ahumanu Highway.

Approximately 25 acres of these lands have been identified by the State Department of Transportation (DOT) for an eventual highway interchange at the entrance to the Project. Thus, industrial/business activity on those lands will be interim uses and only 50 gross acres are seen as long-term light industrial land uses.

Light Industrial/Business Park Market Concept

The Special District is an appropriate area for the proposed uses because:

- Its location on the Island is clearly established as a light industrial zone that serves regional and even Island-wide needs and benefits from proximity to the Kona Airport, Honokohau Harbor and the well-developed visitor infrastructure of the region.
- Kaloko Makai, and in particular its Special District area, is surrounded by other existing and planned light industrial land uses, at both Kaloko Industrial Park to its north, and West Hawai'i Business Park to its south.
- Within Kaloko Makai, the Special District area is less attractive for residential and certain commercial uses because of its Waste Water Treatment Plant, its frontage along a very busy highway, and its relative lack of views due to its lower elevation.
- Light industrial uses could represent a relatively low-investment interim source of income from those lands that would ultimately be taken for public use as a highway interchange.

Light Industrial/Business Park Market Conclusions

In conclusion, the Project's Special District is considered a very appropriate area for light industrial/business park uses. The lands set aside in the Kaloko Makai master plan are expected to be supported by businesses benefitting from the area's general economic growth, as follows:

Projected Demand for Additional Light Industrial/Business Park Lands In the PTA, cumulative gross acres

	2020	2030	2040	Comment
Unentitled demand*	50	50	70	See Exhibit 6-3
Proposed additional supply from Kaloko Makai:				
New development	25	40	75	Timing of DOT interchange taking as depicted is illustrative only.
Less interchange	0	0	-25	
Net additional supply	25	40	50	
Remaining unmet demand	25	10	20	

* In addition to existing light industrial areas and all entitled and planned areas in the PTA. See Exhibit 6-3 for further information.
Source: Mikiko Corporation, 2011.

Kaloko Makai Lodge and Business Center Market

Development Concept and Target Markets

The Kaloko Makai Lodge and Business Center was proposed to cater to business and leisure demands generated by other uses in Kaloko Makai and its region, such as the community's judiciary and medical complexes, its residences and the Kona Airport. The Lodge is envisioned to offer up to 120-rooms, a business center, and meeting and conference spaces.

Target markets would include value- and convenience oriented travelers who do not require resort-like amenities and would prefer a compact, conveniently located and easily accessible place of accommodation. For instance:

- Primary targets:
  - Persons visiting family and friends in Kaloko Makai or neighboring areas;
  - Families and friends visiting or accompanying patients of the hospital;

  - Visiting medical staff involved with the hospital or related medical facilities;
  - Professionals and other parties to proceedings at the Kona Judiciary; and
  - Airline crews and commuters needing accommodations near to Kona Airport.
- Additional targets:
  - Other budget- and convenience-oriented travelers wishing to avoid the congestion, unneeded amenities and higher price points of resort areas; and
  - Athletic teams or other group travel seeking affordable and easily accessible accommodations away from resort the areas.

Substantial shares of the targeted markets are expected to be kama'ainas.

Analytical Approach

The market assessment is framed by visitor and hotel market characteristics and trends for the Island as a whole and for Kona and particular. It is noted, however, that the visitor data available for such analysis does not consider inter-island kama'aina travel.

Because of the relatively small property size (which would represent a less than 1% addition to the Island's visitor inventory) and its nontraditional targeted markets, the analysis also considers selected comparison hotel properties in Kona that are known to serve portions of the visitor markets envisioned for Kaloko Makai.

Conformance to Public Policy

The current County General Plan was developed under the assumption that the "County will continue to pursue the development of a strong multi-market base for the visitor industry that includes .... integrated product development for local products that can generate a healthy small business economic base. The County's visitor industry will continue to successfully grow and expand."[11]

Likewise, the Kona CDP provides for hotels and other lodging facilities within T5 zones such as proposed for Kaloko Makai.

The Lodge and Business Center at Kaloko Makai is planned to be in alignment with these goals and standards.

[11] County of Hawaii, County of Hawaii General Plan, February 2005, pg.1-11.

Lodge and Business Center Market Conclusions

According to the Hawaii Tourism Authority (HTA), 14% of visitors to Kona in 2010 traveled there to conduct business (other than for meetings, conventions or incentive travel, or MCI), to visit friends and relatives, attend sporting events or for other miscellaneous purposes including those traveling on government, military or school business. This "non-pleasure" and "non-MCI" market could theoretically require some 1,000 accommodation units per day[12], a good share of which is likely to be with friends and relatives or in other nontraditional or noncommercial accommodations. However, the remainder of this sizeable market patronizes area hotels and other commercial accommodations for their overnight stays, and is representative of the markets being targeted by the Subject. Inter-island kama'aina business and other travelers are not counted in the HTA data and represent a significant expansion of this potential market.

The target markets appear to be underserved by Kona's current offerings. Review of Kona hotels outside of golf resorts and known to cater to and attract these local and alternative market segments yields only four aging properties (36 to 51 years old), all located in relatively congested Kailua-Kona town. Palamanui, a proposed development to the north of Kaloko Makai, could provide up to 70 such units if it is to be developed as initially planned. While conceived to serve the university to be associated with Palamanui, that new hotel facility could provide a limited offering for some of the markets targeted.

Based on the research conducted and assessment of current and potential future area market alternatives, the Kaloko Makai Lodge and Business Center is estimated to achieve an average daily room rate of about $120 to $130. This considers that it would be a modern, purpose-built and conveniently located facility, better suited to its targeted markets than existing options, and possibly competitive with a future lodge facility at Palamanui.

Given its small size and the potential size of the relatively underserved kama'aina and business market segments targeted, average annual occupancy at the Kaloko Makai Lodge and Business Center is projected at 65% at stabilization.

[12] Total visitor days of 6,796,000 x 14% market share x 6/7 (conversion of days to nights) / 365 days / 2.1 persons per room.

2 - Economic and Demographic Trends

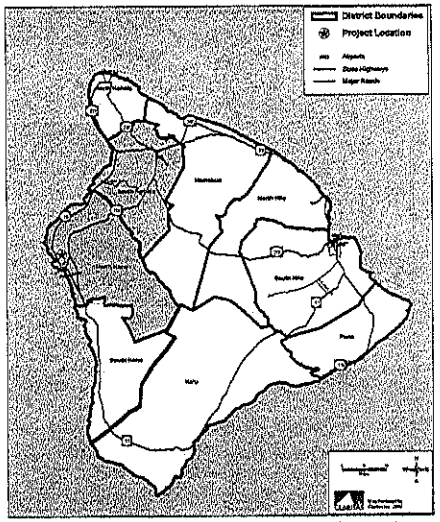
Geographic Areas of Analysis

Judicial Districts

The island of Hawaii (Island) is divided into nine judicial districts. The Kaloko Makai property is in the North Kona District, which extends from Kealakekua in the south, past Kiholo Bay in the north. It includes the Kona International Airport at Keahole (Kona Airport) as well as the resort communities of Keauhou, Kailua-Kona, Kona Village, Hualalai and Kukio.

Adjacent to and north of this district is the South Kohala District, which includes most of the rest of the Island's visitor and second home infrastructure in the resort areas of Waikoloa Beach, Mauna Lani, and Mauna Kea. Other major communities in South Kohala are Waikoloa Village and Waimea Town. These offer both primary and second homes.

Island of Hawaii Districts



Source: Claritas, Inc., 2007. See Exhibit 2-1 for copy at a larger scale.

West Hawaii

The island of Hawaii is often seen in two major divisions, East Hawaii and West Hawaii. Although there is a great deal of commuting from East to West Hawaii, this is in large part a reflection of the lack of appropriate housing opportunities for local families in West Hawaii, rather than an integration of the two divisions' economics.

West Hawaii is commonly defined as the districts of North Kohala, South Kohala, North Kona and South Kona. Within West Hawaii, the North Kona and South Kohala Districts contain the primary drivers of the region's economy, which is currently anchored in the visitor, construction, and related service industries.

Areas of Market Evaluation

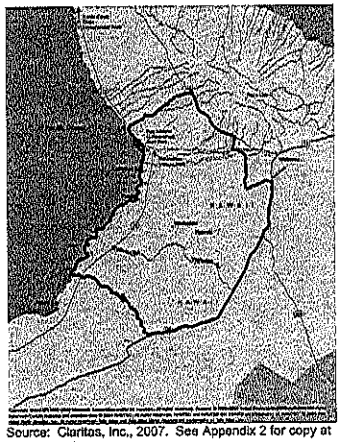
- For purposes of **commercial and industrial market assessment,** Kaloko Makai's "Primary Trade Area" (**PTA**) is considered to encompass all of North Kona and South Kohala, the colored areas of the map on the prior page. While this broad area may be considered to generate the majority of demand for commercial and industrial development at Kaloko Makai, most of the supply that serves this demand is concentrated in the northern parts of the North Kona District.

- For purposes of **residential market assessment,** a tighter area is evaluated, reflecting the need for additional residential supply in the midst of the North Kona and South Kohala Districts, where the majority of West Hawaii's jobs are located. This smaller "Competitive Residential Market Area" (**CRMA**) for residential uses is defined herein to consist of:

Census Tract 215.01 – Portion of North Kona District

Source: Claritas, Inc., 2007. See Appendix 1 for copy at a larger scale.

Census Tract 217.01 – Portion of South Kohala District



Source: Claritas, Inc., 2007. See Appendix 2 for copy at a larger scale.

- "North Kona-North," or Census Tract (CT) 215.01. This area extends from approximately Henry Street in the south to the northern border of the North Kona District. It includes the Kaloko Makai site but excludes Kailua-Kona Town and Keauhou Resort.

- "South Kohala-Waikoloa," or CT 217.01. This area extends from the southern border of the South Kohala District up past Kawaihae in the north. Its major residential community is Waikoloa Village; it excludes Waimea Town.

Island and Statewide Trends and Outlook

Projected Island of Hawaii Population (Exhibit 2-2)

Hawaii Island had approximately 149,000 residents in 2000 and 185,000 in 2010, according to the U.S. Census. Four sources are considered in estimating how population has grown in the interim, and how it is likely to grow over the coming decades.

- **The U.S. Census** provides annual population estimates for counties as of July of each year. The Census estimates the Island's 2010 resident population at 185,079 persons, representing an annual average rate of increase of 2.2% since 2000.

- **Claritas**[1] provided this study with 2010 population estimates and a 5-year projection to 2015. Claritas' figures were prepared based on the Census' 2009 estimate and represent a 2.0% rate of growth since 2000, and 1.6% from 2010 to 2015, which would result in an Island population of 195,460 in 2015.

- **The State of Hawaii, Department of Business, Economic Development and Tourism (DBEDT)** issued its long-term population and economic projections for the state and counties of Hawaii, its "2035 series" in January 2008. The County of Hawaii has adopted this series for its planning purposes, and did not release estimates of population by district as it had with previous DBEDT projections.

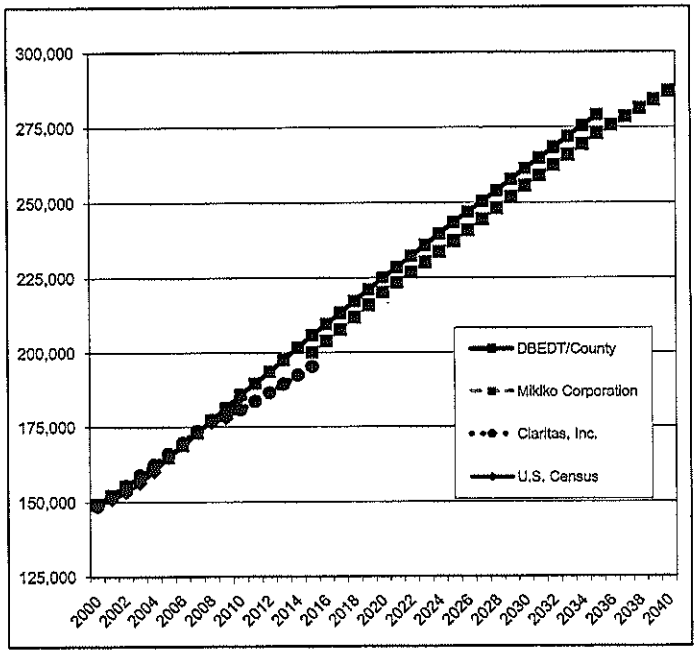
  This latest DBEDT/County series anticipates 279,150 residents on the island of Hawaii by 2035, or 261,340 in 2030, as shown on the chart. This would represent a 1.6% average annual rate of growth from 2010 to 2035. DBEDT and the County assume that growth is faster in the short-term, at 1.9% per annum from 2010 to 2020, and slower in the longer term, at 1.3% per annum from 2030 to 2035.

- **Mikiko** extended the DBEDT/County's 2035 series to 2040, the planning horizon for Kaloko Makai. Mikiko's projection was developed as a conservative view of the long-term future after the 2035 series, with the Island's population growth rate set at 1.0% per annum between 2035 and 2040. This would result in a 2040 resident population of

[1] Claritas derives its information from the U.S. Bureau of the Census, State and local governmental planning and forecasting entities, its proprietary Business-Facts ® database and other sources.

286,900 persons. This relatively conservative view is considered appropriate so as not to overstate demand for residential and commercial uses in the long-term.

Projected Resident Population – Island of Hawaii



See Exhibit 2-2 for sources and further information.

Aging of the Population (Exhibit 2-3)

The changing age-composition of the population will have an enormous impact on home-buying and other consumer spending patterns in Hawaii as elsewhere in the nation. While long-term projected age-cohort data is not available by county or sub-areas, the U.S. Census prepares decennial projections by state.

Viewed in an age pyramid, a most notable feature is the aging of the Baby Boomers, whose members ranged from about 45 to 64 years old in 2010, and will be mostly 55 to 74 by 2020, and 65 to 84 by 2030.

- **2000 to 2010** - As the dominant consumers in the overall marketplace, Baby Boomers fueled a move-up home-buying market consistent with their middle-aged, peak earnings status.

  Age groups showing the most population gains in the 2000 to 2010 period in Hawaii were all over 45:

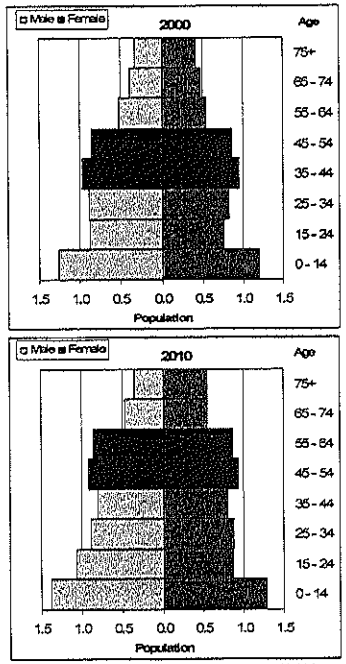
  - 45 to 54: +14,000 persons
  - 55 to 64: +64,000 persons
  - 65 to 74: +16,000 persons
  - 75+: +15,000 persons

- **2010 to 2020** – In the current decade, Baby Boomers will continue to exert strong influence in the housing market. This will be reflected in rapidly growing demand for downsized, retirement and/or other specialized housing types reflecting their empty nester and retiree stages of life. Also notable in this decade will be renewed growth in the entry and early-housing market, represented by persons aged 25 to 34.

  Thus, age groups projected to show the most gains in the 2010s include both early and older homebuyers:

  - 25 to 34: +22,000 persons
  - 65 to 74: +52,000 persons
  - 75+: +21,000 persons

Age Pyramids – State of Hawaii: 2000 and 2010



Note: Each unit on horizontal axis represents 100,000 persons. Highlighted bars include the Baby Boomer cohort.
See Exhibit 2-3 for sources and further information.

- **2020 to 2030** – The last decade for which age-forecast information is available will be characterized by rapid growth of the elderly population, necessitating specialized and age-catered housing solutions.

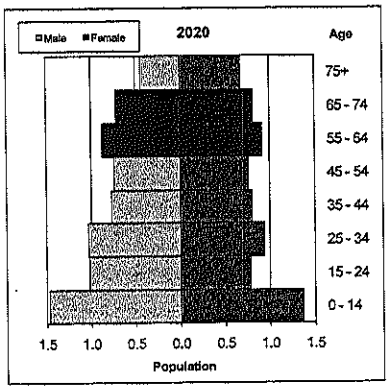
  The second most rapidly growing potential housing market during this period will consist of those aged 15 to 24, an age that usually encompasses household formation, often in rental housing.

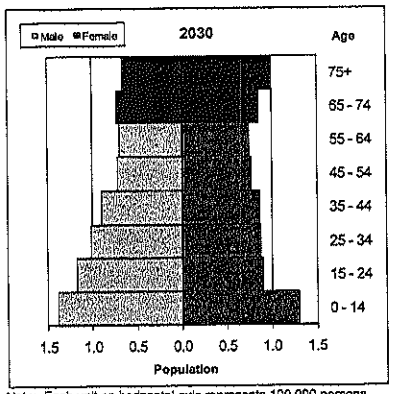
  The third rapidly growing group would be those aged 35 to 44, typically a home-buying or early trade-up housing market.

  Cohorts expected to gain population statewide in the 2020s include:

  - ❑ 15 to 24: + 27,000 persons
  - ❑ 35 to 44: + 19,000 persons
  - ❑ 75+: +56,000 persons

Age Pyramids – State of Hawaii: 2020 and 2030





Note: Each unit on horizontal axis represents 100,000 persons.
Highlighted bars include the Baby Boomer cohort.
See Exhibit 2-3 for sources and further information.

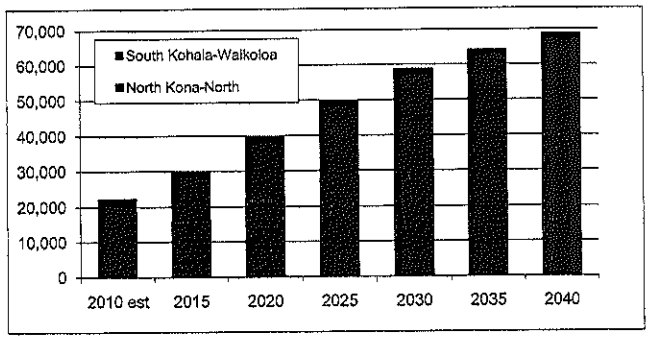
Competitive Residential Market Area Trends and Outlook

Resident Population (Exhibit 2-4)

Mikiko prepared population projections for the CRMA considering the DBEDT/County projection for the island, with Mikiko's extension to 2040. Mikiko's projections assume it is possible and desirable from a policy standpoint that residential opportunity in the CRMA approach the level of employment opportunity in the CRMA.

As of 2010, the CRMA appeared to offer 23% of employment positions on the Island, while housing only about 12% of the Island population.[2] The area includes all seven of the largest nongovernment employers on the Island, including the Hilton Waikoloa Village, Wal-Mart (with locations in Kona and Hilo), KTA Super Stores (with locations throughout the island), the Four Seasons Resort Hualalai, the Fairmont Orchid, Mauna Lani Resort (Mauna Lani Bay Hotel & Bungalows, golf courses and resort operations), and the Hapuna Beach Prince Hotel.[3] Other employers of the CRMA that rank among the island's largest include the Mauna Kea Beach Hotel, Roberts Hawaii, and Hawaiian Airlines.

Resident Population – Competitive Residential Market Area



See Exhibit 2-4 for sources and further information.

[2] This discrepancy appears to be widening: in 2006, Claritas, Inc. estimates suggest the CRMA offered 21% of island jobs, while still housing 12% of its population. This is based on estimates for employees of establishments located in CTs 215.01 and 217.01 in comparison to total employees island-wide. Note that "employees" exceed the "civilian labor force" discussed in a later section, since labor force members may hold more than one job.

[3] As of December 31, 2009, as published by Pacific Business News, "Book of Lists," December 24, 2010; "Big Island Employers – Nongovernment," originally published October 15, 2010.

Additionally, clusters of new development and employment are planned within the CRMA at:

- The University of Hawaii Center at West Hawaii (UHCWH) and its associated community, Palamanui;
- The Natural Energy Laboratory of Hawaii (NELHA);
- Already zoned commercial areas in Keahuolu and elsewhere; and
- Kaloko Makai itself.

Mikiko assumed that the CRMA population reaches its 2010 share of Island jobs within 20 years (achieving 23% of Island population in 2030) and that it tends to stabilize as a center of employment and population thereafter (achieving 24% of the Island population by 2040).

This would result in a 2020 population of some 39,600 persons in CTs 215.01 and 217.01, and a 2040 population of about 68,900. These would represent a doubling of the CRMA's population by 2025 and a 3.8% per annum rate of increase for the 2010 to 2040 period as a whole. These rapid growth rates would contrast with those for the island as a whole, at some 1.5% over the 30-year period.

Number and Age Distribution of Households (Exhibit 2-5)

In terms of households, the CRMA accounted for an estimated 11% of the island total in 2010, according to Claritas. Some 4,200 or 6% of the total were in North Kona-North, while some 3,600 or 5% of the island total were in South Kohala-Waikoloa.

CRMA households tend to be of workforce age, with 80% to 81% headed by a person aged 25 to 64, compared to 73% Island-wide that fell in these age groups.

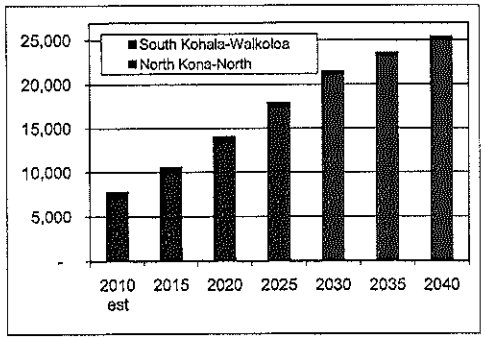
Average household sizes in these areas of interest were estimated as follows:

- North Kona-North: 3.00
- South Kohala-Waikoloa: 2.67
- Hawaii County: 2.68

Projected Households (Exhibit 2-6)

More housing opportunities as well as jobs in the CRMA would enable the uncoupling of some currently doubled up households. Together with age profile changes over time, this will lead to declining household sizes in the CRMA as well as the Island as a whole.

Projected Households – Competitive Residential Market Area



See Exhibit 2-6 for sources and further information.

Considering historical factors and the anticipated growth in workforce population in the CRMA, Mikiko projected future households in the area based on slowing rates of decline in household size. Overall, the projected changes in household size represent a 0.2% per annum decline in North Kona-North, a 0.1% per annum decline in South Kohala-Waikoloa and 0.1% per annum decline in the County as a whole.[4]

It is concluded that the CRMA could accommodate some 25,400 households by 2040, assuming its future housing opportunities are allowed to approach its future employment opportunities. This would represent a need to house some 17,600 more households over the next 30 or so years, considering 7,800 households in the region in 2010.

Households by Income (Exhibit 2-7)

North Kona-North and South Kohala-Waikoloa show a higher household income profile than the Island as a whole, with only 33% of households earning $50,000 or less in 2010, compared to 45% for the County as a whole. Likewise, 30% of CRMA households are estimated to earn between $100,000 and $249,000, while only 24% are in this range for the County as a whole.

Claritas estimates the median 2010 household income is approximately $70,000 in North Kona-North, $69,000 in South Kohala-South, and $67,000 for the Island of Hawaii.[5]

Per capita income in the CRMA was estimated at about $32,000 in 2010.

[4] These factors are similar t those developed by SMS, Inc. in its 2006 housing policy study prepared for the State and Counties of Hawaii, with input from the various housing directors.

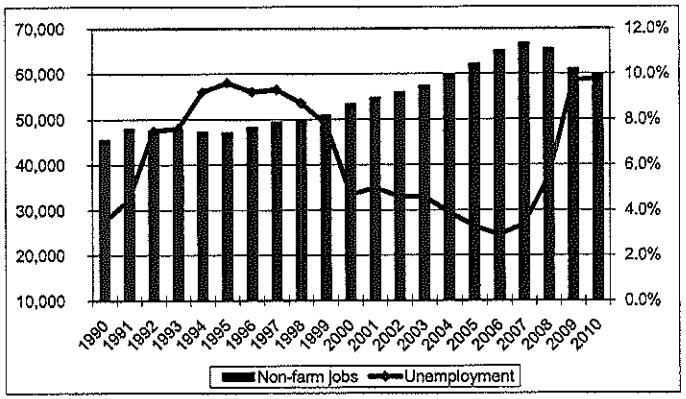
[5] These do not reflect the substantially higher incomes of the region's part-time residents.

Employment Trends (Exhibit 2-8)

Unemployment averaged 9.8% in 2010 for Hawaii County, minimally unchanged from 2009, according to the State of Hawaii, Department of Labor and Industrial Relations (DLIR). This compares to 5.5% in Honolulu County, 8.2% in Maui County and 8.8% on Kauai. Hawaii Island's December 2010 figure was 8.7%, the lowest monthly recording of the year.

However, the favorable unemployment trend has been achieved by a declining civilian labor force, since both employed persons and non-farm wage and salaried jobs have declined in recent years. Non-farm jobs have dipped back to approximately their 2004 level.

Island of Hawaii Labor Force Trends



See Exhibit 2-8 for sources and further information.

3 - Residential Market Environment

Existing and Historical Conditions

Hawaii County – 2009/2010 Inventory Estimates

- **Total units** - Hawaii County had some 80,600 housing units in July 2009, representing 16% of the State's supply, according to the U.S. Census. This was a 7% increase from the 75,000 units reported in July 2006 (Census housing data prior to 2006 may not be comparable)[1].

- **Occupancy and tenure** - The Census update does not provide housing characteristics by County, but recent survey data can be obtained from the Census' American Community Survey (ACS.) The most recent ACS survey, taken in 2007-2009,[2] finds that some 81% of Hawaii County units were occupied and 19% vacant.[3] Among occupied units, 66% were owner-occupied and 34% renter-occupied, a slightly lower ratio of owner-occupancy than evidenced a few years prior.

- **Primary resident vs. non-resident uses** – Most of the County's vacancies are among non-resident units; they do not represent homes available to primary residents. In the ACS survey, 51% of vacant units were held for seasonal, recreational or occasional use, while only 32% were available for rent or for sale (or rented or sold but not yet occupied.)[4] Even this 32% includes some units being marketed to visitor or other off-island consumers.

  Additionally, data from previous ACS surveys show that among occupied housing units, a minimum of 5% are occupied by persons whose usual place of residence was outside of the County[5].

[1] U.S. Census Bureau, Population Division, release date June 2010, as published by County of Hawaii, Data Book at http://www.co.hawaii.hi.us/databook_current/section16.htm . Since 2006, the Census housing estimates include units for group quarter populations, rather than household populations only.

[2] U.S. Census Bureau, American Fact Finder, at http://www.factfinder.census.gov/, as accessed February 25, 2011.

[3] This vacancy rate encompasses units held for occasional and seasonal use (see below) and therefore is much higher than the conservative 5% vacancy assumed to be desirable within the primary housing market later in this chapter.

[4] This finding is consistent with 2000 Census data, which showed 53% of the island's housing vacancies attributable to units held for seasonal, recreational or occasional use, per U.S. Census Bureau, Census 2000, Table DP-1. The remaining 17% of units remained vacant for "other" reasons, according to ACS 2007-09.

[5] Updates of this information do not appear to be available since the 2006 ACS survey.

Applying the 19% vacancy and the 5% nonresident occupancy to the estimated 80,600 total units in 2009 suggests some 61,700 Big Island units occupied by primary residents.

- **RHU vacancy rates** - The 2007-09 ACS survey suggests homeowner and renter-occupied vacancy rates of 3% and 14%, respectively, both slightly up from their ranges two years ago. Weighting these by the mix of owner- and renter-occupied units and considering the minimum 5% of units believed to be occupied by persons who customarily live off-Island, we derive a maximum 6% vacancy rate applicable to primary resident housing units (RHUs) in the County in recent years.

  This is considered a maximum vacancy because both the owner and the rental vacancy rates include units marketed to off-islanders. Also, the 5% share of units estimated to be occupied by persons who normally live off-Island is considered a minimum.

Estimated Vacancy Rate for Resident Housing Units – High Indicator

	Vacancy rate	Mix	Comments
Owner-use	3%	63%	Includes part-time resident owners
Renter-use	14%	32%	High vacancy attributed to part-time use; mix adjusted to exclude 5% as noted below
Occupied units (off-island residents)	0%	5%	Minimum share of units occupied by off-islanders
Overall	**6%**	**100%**	**High vacancy indicator for RHUs**

Source: Mikiko Corporation, 2011.

- **RHU inventory** – Finally, the 2009 inventory of **RHUs in the County is estimated at fewer than 65,600 units**, which is derived from the 6% vacancy on top of the 61,700 estimated occupied units available for long-term use by primary residents.

North Kona-North and South Kohala-Waikoloa Inventories

While the ACS does not break out housing supply by area, according to data obtained from Claritas, about 10,300 or an estimated 13% of the Island's 2009 gross housing stock (including non-resident units) was located in the CRMA.[6] About 24% of these area units were vacant in 2010, according to Claritas.

The CRMA's very high vacancy rate reflects its many resort second home communities including Mauna Kea, Mauna Lani, Waikoloa Beach, Hualalai, Kukio and Kaupulehu. Because of its visitor orientation, the CRMA has a far greater share of units held for seasonal, recreational or occasional use than the County as a whole. While current Census or ACS data is not available on this point, it is well established by observation and the previous Census:

- An April 2009 survey by Mikiko identified more than 2,400 resort residential units at just these six golf resort communities. Many other units in off-ocean settings such as at Waikoloa Village and developments throughout the Kaloko area are also known to include disproportionate shares of units purchased as second or vacation homes.

- The 2000 Census indentified 1,604 units held for seasonal, recreational or occasional use in CRMA areas; these represented 82% of all housing vacancies in these areas.

Considering these factors together, **RHUs in the CRMA were estimated at no more than 7,800 units as of 2010**, representing an estimated 76% of the area's total estimated housing stock.

This conclusion corroborates the 24% vacancy rate among the area's 10,300 gross housing units (including non-resident units) in 2010; the great majority of those vacancies are understood to be outside of the primary housing sector.

Residential Building Permits (Exhibit 3- 1)

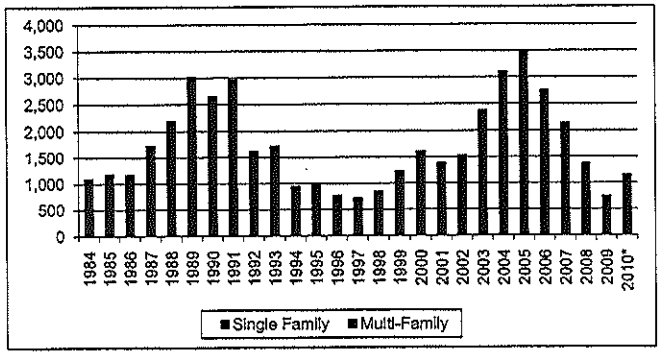
Hawaii County residential permitting is dramatically cyclical and evidenced a trough from 1994 to 1998. Within two years thereafter, permitting activity increased rapidly, culminating in a record 3,469 residential permits obtained in 2005. Activity has plunged since then, with fewer than 800 permits obtained in 2009, a level matching the prior trough of 1996-1997.

According to the County, moreover, the majority of the 2009 permitting activity was in Puna and South Hilo; only 17% of it was in the South Kohala or North Kona districts.

[6] Note Claritas data is estimated for 2010, while total island data is estimated for 2009.

The year 2010 may have marked an upturn to a new cycle, with total residential permits reaching 1,149[7]. The positive results in 2010 were driven principally by development activity in the multifamily market.

Building Permits – Hawaii County



* Annualized based on data through November 2010
See Exhibit 3-1 for sources and further information.

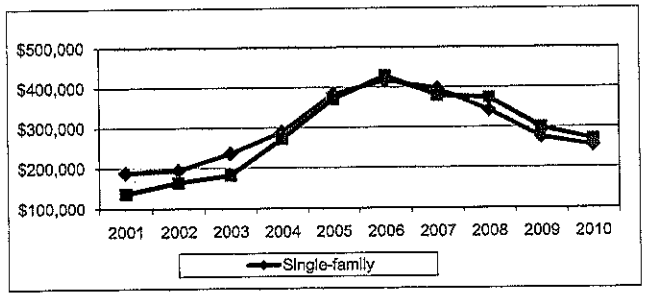
Residential Market Trends

Island-wide Resales (Exhibit 3-2)

Rapidly rising home prices through 2006 reflected a strong local economy and labor market, as well as favorable financing conditions. However, in subsequent years, prices fell for both single-family homes and condominiums.

[7] Based on 1,149 new housing units as of November 2010, annualized. County of Hawaii: Department of Research & Development - County of Hawaii Statistics; http://www.hawaii-county.com/info/stats.html

Hawaii Island Resales – Median Prices



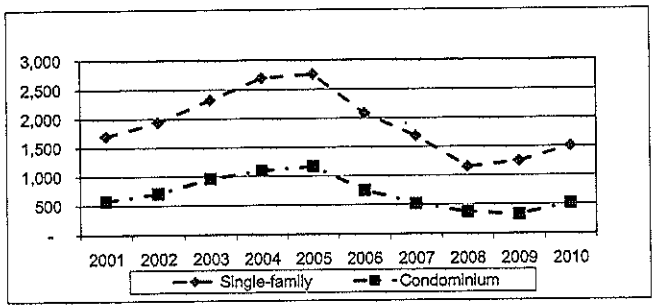
See Exhibit 3-2 for sources and further information.

After 2009, conditions appeared to be stabilizing, with still declining prices but more sales recordations. The ongoing price impairment is attributed to lingering softness in the local (as well as national) economy, as well as distress sales of properties that were purchased at high prices in prior years, that continue to suppress the overall market.

- **2010 prices** - Median single-family and condominium sales prices in 2010 were down 7% and 10% respectively, from 2009, to $255,000 and $270,000.

- **2010 sales** - Meanwhile the number of sales rose 21% over 2009 levels to 1,503 units transacted in the single-family home market, and 58% to 519 units in the condominium market.

Hawaii Island Resales – Number of Transactions



See Exhibit 3-2 for sources and further information.

Sale recordations of existing homes during the first month of 2011 show the number of sales increasing 17% for single-family and 48% for condominium units. The median sold price for a single-family home was $220,000 while the median condominium sold for $219,000, according to data provided by Hawaii Information Service.[8] The single-family price is a modest 6% drop from January 2010, but a dramatic 47% decline from the recent high of $416,100 achieved in 2006. The January 2011 median condominium price is down 18% from January of last year, and 49% below the product's peak price of $428,200, also in 2006.

The short-term outlook is for continued firm sales, while prices may continue to decline in the near-term due to distress sales, local labor market weakness, ongoing real estate market softness in Hawaii's off-island source markets, and more stringent credit standards. However, longer-term, ongoing population growth, household formation and pent-up desires over the past few years will fuel demand for new housing throughout the County and especially in economically developing areas such as West Hawaii.

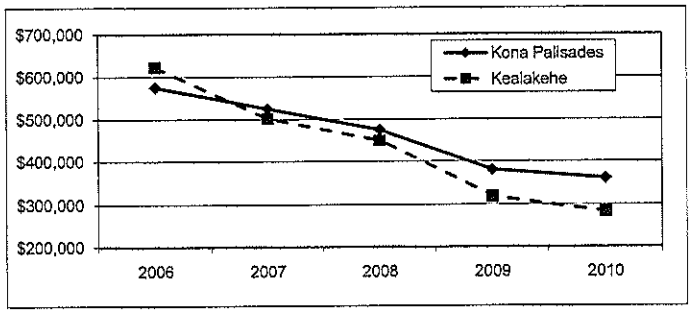
Sales in Selected Areas, North Kona-North (Exhibit 3-3)

Residential sales in the Kona Palisades and Kealakehe communities of North Kona-North are examined in further detail because of their locational similarities to Kaloko Makai. However, at the present time, both these areas are well-established primary residential communities with a predominance of single-family product; they offer fewer insights to new built product and to the potential market for multifamily primary homes.

Like the Island-wide trend, prices in the indicator neighborhoods have declined since 2006. As of October 2010, Kona Palisades showed median prices of $360,000 for single-family sales and $325,000 for condominium sales, although there were only 11 of the latter. In Kealakehe, the median single-family home sold for $284,000, reflecting only 16 sales, most of which are believed to be DHHL sales. There were no condominium sales recordations in Kealakehe as of October 2010.

[8] Gomes, Andrew, "Big Island, Kauai home prices mostly lower in January," Honolulu Star Advertiser, February 7, 2011.

Residential Sales in Kona Palisades and Kealakehe – Median Price, Single-Family Homes



See Exhibit 3-3 for sources and further information.

The number of sales has also generally declined or held steady since 2006, with some rebound in 2007, especially in the multifamily market (Kona Palisades).

Housing Market Outlook

Potential New RHUs in the CRMA (Exhibit 3-4)

Mikiko conducted a survey of planned residential projects within the CRMA, or CTs 215.01 and 217.01. This survey targeted projects of 100 units or more for which State Land Use Commission (LUC) Urban designation was in place as of December 2010, and/or for which the landowner may be exempt from LUC governance.[9] The planned units reported are the maximum allowed by existing entitlements, and/or the maximum currently planned for development, whichever is lower. As such, these counts likely overstate future production, since most projects are not built to their ultimate entitled or planned capacity. Planned totals were also adjusted according to the share of development anticipated to be used in the primary residential market, as opposed to a second home or other non-resident market.

At the current time, many projects are reported to be on hold, but even where previous development agreements may have expired or current borrowers may be in default, the underlying land entitlements would permit similar development plans once the market begins to recover.

[9] The inventory excludes potential residential developments on Queen Lili'uokalani Trust lands in Keahuolu, where some Land Use Commission-Urban designations may already be in place, but could be stalled and/or designated for uses no longer contemplated. QLT is preparing a petition to the LUC for review of the uses of these lands.

The survey does not consider emergency shelters, dormitory beds, or other group living quarters.

- **North Kona-North** - Some 6,300 future RHUs on LUC-Urban lands were identified at 12 projects in CT 215.01, not including Kaloko Makai. The largest projects involve State lands and include significant restrictions by income and/or Native Hawaiian ancestry. The five largest projects in the district are:

  - **Kamakana Villages** by Forest City on State HHFDC lands – 2,330 units, estimated at 2,210 RHUs;
  - **Kaloko Heights** by SCD – 1,362 units, estimated up to 1,020 RHUs;
  - **Villages of La'i 'Opua** by DHHL – 872 more units (in a community of over 1,000 at completion), or some 830 potential future RHUs;
  - **Keahuolu,** adjacent to La'i 'Opua and also proposed by DHHL, but longer-term – 750 units or up to 710 RHUs; and
  - **Palamanui** by Hunt Development Group and Charles Schwab – 1,116 units or some 890 potential future RHUs in association with a new University of Hawaii Center at West Hawaii (UHCWH) campus.

  Also in the immediate vicinity of Kaloko Makai is Kula Nei, a proposed 216 to 220 lot (plus affordable housing) development which is reportedly experiencing financing problems.

  Nearby Kohanaiki, a luxury golf and second home development on the makai side of Queen Ka'ahumanu Highway, is notable but not included in the inventory of RHUs used in this assessment because of its market orientation. Even if Kohanaiki were to be replanned in the future, its ocean orientation and high-end golf and other infrastructure are likely to ensure that it remains a resort/second home- rather than a primary housing community.

- **South Kohala-Waikoloa** shows some 2,300 future units entitled and planned, at seven projects. The largest in terms of potential future RHUs are:

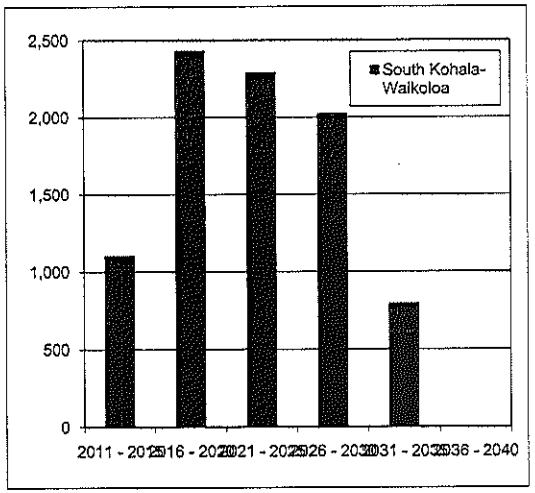
  - **Kamakoa Nui,** a workforce housing project initiated by the County of Hawaii in Waikoloa Village – up to 1,200 total units, estimated at 1,140 RHUs;

  - **Keolalani at Waikoloa** by Keolalani Investment Partners – potentially up to 2,000 units but only 500 or so considered likely to ever be developed as RHUs; and
  - **Wehilani,** Castle & Cooke's master-planned community in Waikoloa Village, where some 700 more units, or an estimated 490 more RHUs are planned.

While most units at these projects could be expected to be developed by 2030, development or conditions specific to certain sites or projects could delay some into the 2030s, and preclude others altogether.

As also noted, these potential inventories are likely generous since they consider current zoning or plan maximums and active development schedules. Often projects are developed at less than their permitted or planned densities, and/or experience delays that push inventory further into the future.

Potential New Resident Housing Units – Competitive Residential Market Area



See Exhibit 3-4 for sources and further information.

Summary of Island Demand and Supply (Exhibit 3-5)

- **Current and future demand** – As presented previously in Exhibit 2-6, in order to begin to address the Island's imbalance of jobs and primary resident housing, the number of households in the CRMA would have to nearly double from the estimated 7,800 in 2010, to more than 14,000 in 2020, and then continue to increase to some 25,400 by 2040. This suggests a need to provide housing for some 17,600 new households over the next 30 years.

While there is likely current pent-up desire for household formation within the region, this has not materialized as significant demonstrable market demand in recent years due to the currently soft economic conditions in the County. Therefore, current pent-up demand is assumed to be zero.

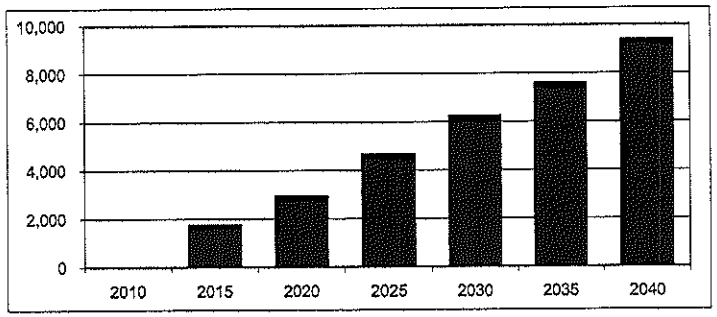
- **Current supply** – The current supply of RHUs in the CRMA is estimated at 7,800 units, as presented at the beginning of this chapter.

- **Future supply** – Future supply estimates are based on a hypothetical schedule of LUC-entitled maximum developments in the CRMA. The identified projects could potentially produce up to 8,600 new units by 2040, as shown previously in Exhibit 3-4. From this figure a 5% vacancy allowance is deducted, resulting in some 8,200 new units available for resident housing use.

Taken together, the outlooks for RHU demand and entitled potential supply indicate a growing shortfall in permitted housing opportunities. Even hypothesizing aggressive and sustained housing production efforts, without further State entitlement of additional housing developments in the CRMA, the unmet demand for housing could trend up to more than 9,400 homes by the year 2040.

This deficit could materialize as a steady increase in the amount of pent-up demand as current inventories of State-entitled residential properties expected to serve primary housing markets become developed and absorbed, while demand increases steadily. Without further entitlement, today's imbalance between the locations of Island employment and housing opportunities will only be magnified, with likely social repercussions.

Resident Housing Unit Deficit in the CRMA
After Development of All Currently State-Entitled Lands



Source: Mikiko Corporation, 2011. See Exhibit 3-5 for further information.

4 - Residential Market Assessment

Future Housing Market Setting

Demand Generators (reference Exhibit 3-5)

SCD-TSA anticipates Kaloko Makai's first housing units could be available for occupancy in 2015. While today's economy is still in transition, the recent years of minimal household formation and housing development are expected to result in substantial pent-up demand for primary resident housing in the near future. Mikiko estimates that by 2015, RHU supply in the CRMA might be more than 1,700 units short of what could be desired by Island residents, even in the unlikely event that there is aggressive development in the interim.

Demand generated during subsequent years of the Project's marketing will originate from new household formation as well as from existing Island households wishing to move into the area. This new demand can be characterized as:

- **Downsizers** – The Baby Boom generation should be in its peak "downsizing mode" between 2010 and 2020; after 2020, a larger share will be entering their mid-60s than their mid-50s. Many members of this older generation can be expected to seek to live closer to town centers as their children move out from home, they enter retirement and/or as they no longer care to maintain a large home.

  Also after 2020, the 55 to 64 age cohort could decline as Baby Boomers move into their 70s. This may also fuel downsizing (see "senior markets," below.)

- **Entry level markets** – Hawaii's next most rapidly growing cohort between 2010 and 2020 is likely to be persons aged 25 to 34, the "Echo Boom" generation. Households are typically formed during one's mid-20s to early 30s, and one's first rental or home purchase is often made during this phase of life. Since affordability is key to this market and many do not yet have spouses or children, this market also tends to accept smaller units.

- **First move-ups** – A strong move-up market could emerge after 2020, as the Echo Boom cohort ages into its mid-30s and early 40s.

- **Retirement/senior markets** – The retiree/senior market will show significant gains between 2010 and 2030. Typically one or two persons per household, this market may be amenable to more dense housing, and often must move to meet specialized housing needs.

Several of these household types are expected to be willing to accept more dense living environments and to value accessibility to community amenities. Kaloko Makai's location could be attractive to these growing market segments because of its proximity to

existing and future anticipated Island jobs, future transit routes, the shoreline and regional parks, shopping and entertainment, the Kona Airport and the many planned investments in public and private infrastructure throughout the CRMA region.

Housing Demand and Supply (reference Exhibit 3-5)

Currently entitled projects are estimated to yield up to 8,200 of the potentially demanded 17,600 RHUs in the CRMA by 2040, if they are built out within this time frame and developed to the maximum levels of their respective current plans and entitlements.

Despite an assumed strong and sustained rate of new RHU home production throughout the study period, entitlements within the CRMA account for only about half the projected need. Therefore, without further land entitlement, the area could still face an approximately 9,400-unit shortage by 2040:

Supply and Demand for New Resident Housing Units - Competitive Regional Market Area, 2010 to 2040

Future Demand	Pent-up demand, 2010	0*
	Future need, 2011-2040	17,600
	Total need	17,600
Future Supply	Planned and entitled (8,800 less 5% vacancy), rounded	8,200
Shortage	**As of 2040**	**9,400**

* Assumed to be zero due to current economic environment.
Source: Mikiko Corporation, 2011. See Exhibit 3-5 for further information.

The anticipated area housing shortage appears to be particularly acute beginning in the late 2020s, when many of today's planned projects could have already delivered most of their entitled inventory.

Kaloko Makai's Proposal

Meeting Community Desires

Kaloko Makai has been planned to respond to its community's desires regarding future growth, as expressed in the Kona Community Development Plan.[1] The Kona CDP directed growth to compact, higher density "villages" mostly located north of Kailua-Kona Town along the Ane Keohokalole Highway transit corridor. These growth centers were expressed as 10 Transit-Oriented Development (TOD) Urban Villages, of which Kaloko Makai is identified as one.

[1] Wilson Okamoto Corporation, for the County of Hawaii Planning Department, "Mapping Kona's Future: Kona Community Development Plan," September 2008.

The County of Hawaii has subsequently established more concrete guidelines for these TOD areas in its Kona Village Design Guidelines.[2]

Kaloko Makai's residential plan, like its community plan as a whole, begins with these community and public guidelines.

Development Concept

Kaloko Makai is planned to respond to the market and demographic trends as well as the community desires discussed above. It will serve a County population that is changing rapidly in terms of size, geographic dispersion, age profile and lifestyle. It will deliver needed homes in a diverse, planned community.

Thanks to the gradual slope of much of the site, Kaloko Makai will offer ocean and/or regional views from a substantial share of its residential, parks and other areas. From a housing standpoint, the plan concept features a transit-ready Urban Center (Transect zone T5) on Ane Keohokalole Highway, with lower density General Urban (T4) and Sub-Urban (T3) areas. Based on the Final Draft Kona Village Design Guidelines, the T4 and T5 areas would be mostly multifamily, while the T3 areas would have more single-family residences. A Special/Mixed Use district in the lower portion of the site may also include some multifamily housing.

Residential Product Mix

Although exact outcomes will depend on the agreements to be reached with the County, some 700 units, or 14% of Kaloko Makai's homes are assumed to be built as "affordable" housing, based on current County guidelines. Affordable housing could be offered as for-sale or rental units, but has been addressed in this report as for-sale units.

The balance of homes at Kaloko Makai will be its 4,300 "market" homes, ranging from traditional single-family homes to mixed use, mid- and higher-density multifamily units. A conceptual maximum development scenario for the Project is as follows:

[2] Place Makers, LLC, "Kona Village Design Guidelines" (calibrated for the County of Hawaii), Final Draft, October 10, 2010.

Conceptual Mix of Residential Units at Kaloko Makai
Maximum development at buildout

Predominant unit type	Transect zone	Total planned units	Example density (units per acre)
Multifamily ("affordable")	Special District and/or T5	700	13 to 17
Multifamily ("market")	T5	2,274	7 to 13
Multi- or single-family ("market")	T4	1,206	7 to 8
Single-family ("market")	T3	820	3 to 6
Total		**5,000**	**3 to 17**

Sources: Place Makers, LLC, 2010; SCD-TSA Kaloko Makai, LLC; Wilson Okamoto Corporation, 2011.

The majority of homes at Kaloko Makai would be offered in compact or multifamily settings, in adherence with the Kona Design Guidelines noted previously. The conceptual plan shows the maximum proposed inventory of 5,000 units. The exact total number and mix of units by type will be determined upon finalizing agreements with government agencies and during the years of build-out, as market conditions and preferences materialize.

Comparison Project Characteristics (Exhibit 4-1)

In order to develop market conclusions regarding the proposed product types, several North Kona and South Kohala projects were identified and evaluated in terms of their development densities, pricing and absorption. Today's market pricing is highly impacted by foreclosures and short sales, as well as tighter lending and the fact that many developers are simply trying to liquidate the standing inventory they were left with when market conditions deteriorated. Thus, price indicators gathered for the same projects in previous years are also considered.

The survey results are presented in Exhibit 4-1, and are tied to the proposed market products at Kaloko Makai as follows:

- **Suburban T3 Zone – Predominantly single-family** (proposed at 3 to 6 units per acre):
  - South of Kailua-Kona, D.R. Horton-Schuler Division's Pualani Estates development offers single-family homes on lots of 5,000 to 8,000 square feet. Recently recorded prices range from $315,000 to $528,000, and averaging $403,000. This is down from historical average indicators of $489,000 (2008-09) to $557,000 (2007).
  - Castle & Cooke's Kikaha development in Waikoloa Village provides a recent example of single-family development at 3 units per acre, or an average of 10,000 square feet per lot. In 2010, Kikaha units sold for $380,000 to $568,000, averaging $453,000; in 2009 they ranged from $379,000 to $450,000 with an average of $424,000.
- **Urban T4 and T5 Zones - Multifamily market units** (proposed at 7 to 14 units per acre for market units):
  - The CRMA has seen few if any primary housing products that straddle the multifamily and single-family development concepts. The Pines at Kailua-Kona, a condominiumized, zero-lot line single-family detached home project developed in 1989 and 1990 appears to be the best such comparable, at 6.8 units per acre. The few recorded sales in 2010 averaged $277,000, but these units have recently shown average prices in the range of $369,000 (2008-09) to $425,000 (2006-07).
  - Castle & Cooke's Makana Kai at Wehilani is the only market priced, mid-density, multifamily RHU property recently marketed in the CRMA. Five recorded sales in 2010 all appear to be bank foreclosures and subsequently discounted REO sales, and are thus considered less representative of a longer term trend in pricing. (Developer sales at the project were completed in 2009.) Recent historical prices at Makana Kai range from $337,000 to $400,000+ in 2006-07, or $225,000 to $295,000 in 2008-09.
  - Two Kailua-Kona projects were also evaluated, Alii Cove and Alii Park Place. Both of these developments are in a visitor region and appear to allow short-term rentals. However, they are located mauka of Alii Drive, are relatively new, and at 11 units per gross acre, are some of the highest-density multifamily projects in West Hawaii that were not built as affordable housing but still include a substantial share of primary residents. In 2010, sales at Alii Cove and Alii Park Place averaged $306,000 to $331,000, respectively. In 2008-09, the same projects showed averages of $415,000 to $427,000.

Assessment for Kaloko Makai

Anticipated Buyer Markets

The proposed products respond to the market opportunities identified above as follows:

- **Entry-level markets** – Those units designated as affordable units, as well as many of the multifamily market units are conceived to appeal to entry-level markets, typified by the rapidly increasing 25- to 34-year-old Echo Boom cohort in the 2010 to 2020 period.

- **Move-up markets** – Kaloko Makai's single-family products could appeal to move-up markets and growing families.

  - The first level move-up market, typified by persons aged 35 to 44, is projected to grow particularly rapidly in the 2020 to 2030 period as the Echo Boomers mature.

  - A more affluent move-up market could also be attracted to the views, convenient location and lifestyle offerings at Kaloko Makai.

- **Downsizers** – Kaloko Makai's more compact single-family and some of its multifamily units are seen to appeal to the Baby Boomer cohort that is looking to simplify its lifestyle, lessen homeowner commitments and enhance access to town amenities. This market may overlap with the retiree segment described below.

- **Retirement/senior markets** – All of the multifamily units and some of the single-family product could appeal to retiree markets. The age 70+ population will be a rapidly increasing age classification especially towards the latter years of Kaloko Makai's marketing.

Based on the Project location, development concept and the comparison projects surveyed, some 85% of Kaloko Makai residents are anticipated to be primary Island residents. However, some product types could also appeal to second home buyers or investors that may come from off-Island.

Projected Sales Prices (Exhibit 4-2)

The pricing conclusions for Kaloko Makai are presented in Exhibit 4-2 and summarized as follows.

Market Unit Price Conclusions for Kaloko Makai
2010 dollars

	Average sales price*	Approximate average density (units/gross acre)
T3 – predominantly single-family	$475,000	3 to 6
T4 – small lot single-family and/or multifamily	$390,000	7 to 8
T5 – predominantly multifamily	$345,000	7 to 13
Overall, market homes	**$382,000**	**3 to 13**

* For market-priced units only.
Source: Mikiko Corporation, 2011. See Exhibit 4-2 for further information.

The preceding does not consider the affordable units that would also be developed on-site. Their pricing would be set in accordance with County or State guidelines to be determined. Likewise, rental rates, assuming some affordable housing units are developed as rentals, would also be based on County rules then in effect.

For illustrative purposes, according to County guidelines in effect as of September 1, 2010, conforming prices for such housing could range from $202,500 to $366,200 for two-to four person households with incomes ranging from less than 80% up to 120% of the County median. County price guidelines also show one- to two-bedroom rental units priced from $1,037 to $1,500 per month, including utilities, and offered to households earning 80% to 100% of the median income.[3]

Projected Supportable Sales Absorption (Exhibit 4-3)

It is concluded that Kaloko Makai's 5,000 homes could be absorbed over about 26 years at an average long-term rate of about 190 units per year. Actual sales from year to year would vary depending on market cycles and the types of units available for sale at any given time. The Project's inventory could represent a significant solution for the

[3] County of Hawaii, Office of Housing and Community Development, "Affordable Housing Guidelines for the County of Hawaii," 2010.

anticipated future unmet demand for some 9,400 new housing units in the CRMA through 2040, based on currently LUC-entitled projects and their plan maximums.

These conclusions consider:

- A variety of product types at varying prices (including affordable units) to be offered simultaneously at Kaloko Makai;
- The near-town location, good views, resident-oriented pricing and community amenities planned for Kaloko Makai;
- The experience of other product types at the selected comparison projects;
- The strong future demand for new housing in the CRMA, which is projected at an average of more than 500 units per year through 2040 (see Exhibit 3-5).

An illustrative mix of the overall Project absorption is as follows:

Illustrative Summary of Maximum Potential Residential Sales Absorption at Kaloko Makai

	Affordable homes	Market homes	Maximum total housing
Maximum inventory	700	4,300	5,000
Average annual sales*	28	166	190 (rounded)

*Assumes several products are marketed simultaneously in any given year. Thus, sales periods for some project types may extend over a longer period than others, and the overall average rate may be less than the sum of the two sub-market rates shown.
Source: Mikiko Corporation, 2011.

Alternatively, if the community develops at less than its maximum plan of 5,000 units, or if some of the units are developed as rental products, the residences could be absorbed more rapidly.

5 - Commercial Market Environment and Assessment

Background

Analytical Approach

This chapter presents a review of area retail and office market conditions and a market assessment for commercial facilities proposed at Kaloko Makai. As proposed, Kaloko Makai would include a new regional hospital and judiciary facilities. While these elements are significant to the land planning and conceptualization of market opportunities, this commercial market assessment does not assume their development.

While the proposed hospital and judiciary complexes may create myriad employment and enterprise opportunities not already evident in the region, the commercial market assessment is based on a more conservative view of retail- and office-based factors as evidenced within a defined competitive area in 2010. To the extent that a new hospital or judiciary does attract private commercial demand, that demand is considered a portion of the overall commercial demand that is assessed.

Additionally, although many retail shopping centers include substantial office space, and office buildings often include retail, comparison properties are classified as one or the other based on the predominant use or representation of type by property managers.

- **Retail** - The market assessment for retail space compares retail supply to area daytime populations. Daytime population consists of residents of an area, less those who may be away during the daytime for work or other purposes, plus those who may live elsewhere but are in the area during the daytime, such as those employed in the area. The Census estimates daytime population for primary residents of the area; to this Mikiko adds average daily visitors. Daytime population is a better indicator of commercial demand in West Hawaii than resident population because of the strong influences of visitor spending and commuting workers on area commercial markets.[1]

- **Office** – Demand for office space is related to civilian employment among residents of the region. Government office buildings are not considered, since their development and placement is often a matter of policy and budget processes rather than market characteristics.

  Therefore, this assessment would not include public office spaces that may be associated with a new courthouse at the judiciary complex, nor doctors' and other offices that may be located within the hospital structure.[2]

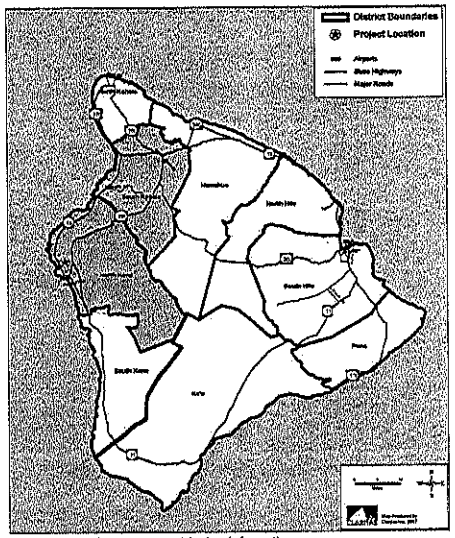
[1] Part-time residents of the region are another potentially very significant market segment, but this source is not evaluated quantitatively here.

[2] The hospital and related medical facilities are assessed separately, in a market study being prepared by Cattaneo & Stroud.

Primary Trade Area

The Primary Trade Area (PTA) for commercial uses at Kaloko Makai is considered to be the entire North Kona and South Kohala districts of the Island. This is a larger reference area than the CRMA considered in the residential market review. This larger area of interest for commercial purposes is appropriate because:

Primary Trade Area



See Exhibit 2-1 for sources and further information.

- Commercial establishments in North Kona, and particularly its northern half, CT 215.01, serve broad regional markets on the Island that extend far beyond this CT. Obvious examples of this are Costco and The Pottery Terrace, the latter being the largest office building on the Island.

- There is evidence of significant commuting within North Kona and South Kohala, meaning that residents travel within the area for work, children's schooling or other activities. Hence, they may shop or patronize businesses within a broad area.

- There is a large daily visitor population in the PTA, mostly accommodated along the coastline. A significant share of this population is likewise considered quite mobile within the region, since they are at leisure.

North Kona and South Kohala also serve commercial markets that originate outside their borders. These sources of market demand are not addressed quantitatively in this analysis, and hence the conclusions expressed could be considered conservative.

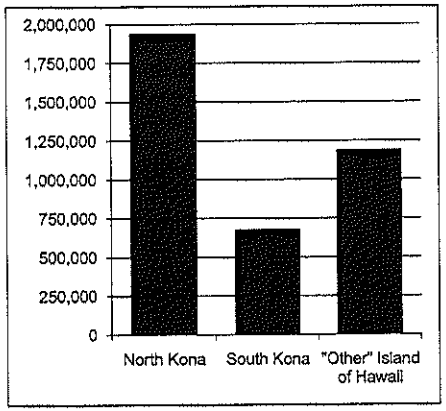
Commercial Supply

Existing Retail Supply in the PTA (Exhibit 5-1)

The PTA had over 2.6 million square feet of retail space in place as of December 2010. About 74% or 1.9 million square feet of this was located in the North Kona District. The PTA accounts for about 68% of the Island's entire retail-based commercial gross leasable area (GLA), which was estimated at 3.8 million square feet.

In, Hawaii Island's retail market showed an 8% average vacancy. The PTA exhibited softer conditions, with an average vacancy of about 10% as of November 2010[3]. Within the PTA, vacancies are slightly higher in South Kohala, where the Queen's Marketplace and additional space at the Villages at Mauna Lani recently opened.

Existing Retail GLA – Island of Hawaii
(square feet)



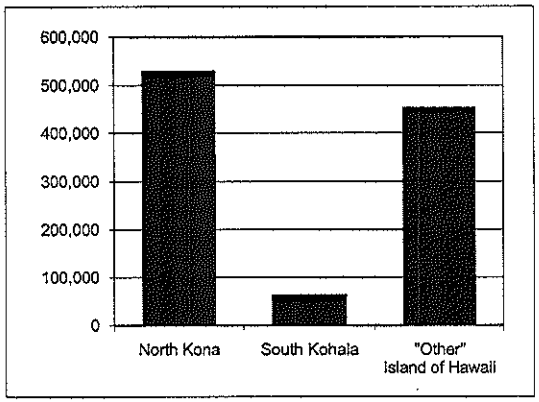
See Exhibit 5-1 for sources and further information.

[3] Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc., custom report, December 2010.

Existing Office Supply in the PTA (Exhibit 5-2)

Office supply and demand is evaluated in terms of rentable building area (RBA), also expressed in square feet. As for retail, North Kona dominates the office-based supply in the PTA, with an estimated 529,000 square feet of RBA, compared to only 63,000 in South Kohala and some 450,000 elsewhere on the Island. The PTA as a whole is estimated to support about 57% of the County's office-based RBA.

Existing Office RBA – Island of Hawaii
(square feet)



See Exhibit 5-2 for sources and further information.

Office vacancies were about 18% in North Kona, 21% in South Kohala, and 13% for the Island as whole, as of late 2010.[4]

Planned and Future Space in the PTA (Exhibit 5-3)

A total of 2.2 million square feet of planned commercial inventory was identified in North Kona and South Kohala, not including Kaloko Makai.

[4] Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc., custom report, December 2010.

Within the PTA, North Kona is the focus of commercial development interest, with an estimated 1.8 million square feet of potential retail- and/or office-based commercial spaces proposed on lands that are entitled and planned for commercial development, as of December 2010[5].

- The largest potential site identified is on lands being marketed by the State of Hawaii, **Department of Hawaiian Home Lands**, across from the Kona Airport. Net of likely light industrial uses, these lands are anticipated to support some 400,000 square feet of future commercial spaces. Another 245,000 square feet of commercial lands could materialize on other DHHL lands in the area, within the Villages of La'i 'Opua.

- Also notable is buildout of the **Kona Commons**, where some 305,000 square feet could be added to the approximately 295,000 square feet that opened in 2008 and 2009. This "lifestyle" center sits on lands leased from Queen Lili'uokalani Trust Estate in the Keahuolu area.

South Kohala has some 400,000 square feet of commercial area proposed at two locations: the proposed Kohala Place at Waikoloa, and in Waimea Town, where prior plans are under review.

Specific projects from which these estimates were derived are presented in Appendix 4.

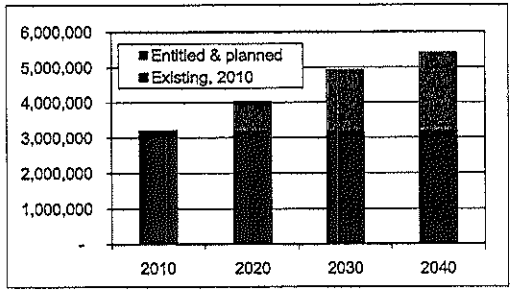
[5] As for residential developments, this analysis considers only those proposals on lands designated Urban by the LUC as of December 2010, and/or those that are exempt from LUC governance. Among the potential developments thus considered are 286,000 square feet on Queen Lili'uokalani Trust (QLT) lands that are currently LUC-Urban but that QLT is understood to be preparing to petition the LUC for review of these land uses. It is not known at this time how that petition might change commercial plans for these lands, nor whether it will be successful. QLT also owns the lands underlying the Kona Commons development, on which a further 305,000 square feet of development is reportedly possible; that potential future inventory is also accounted for.

Additionally, commercial developments within projects designated for industrial use are not considered. These would include the West Hawaii Business Park and Kaloko Industrial Park.

Future Trade Area Inventory (Exhibit 5-3)

If all of the planned and entitled projects identified were developed to their full capacity, and no existing retail- or office-based centers were demolished, the PTA's commercial inventory would increase by some 40% by 2040, to 5.4 million square feet.

Potential Future Commercial Space - PTA (cumulative square feet)



See Exhibit 5-3 for sources and further information.

Commercial Supply and Demand Relationships

Area Resident Profiles (Exhibit 5-4)

The PTA was home to some 55,300 persons, representing an estimated 31% of the island's population in 2008. Claritas estimated that the PTA population grew 2.9% per year after 2000, compared to 2.0% for the Island as a whole.

North Kona's median age in 2010 was about 39, somewhat older than South Kohala, where the median age is estimated at 36. North Kona's median age is similar to that of Hawaii County, which was estimated at 38.

Daytime Population Ratios (Exhibit 5-5)

Daytime populations within the Trade Area and benchmark market are estimated based on 2000 ratios prepared by the US Census within Census Designated Places (CDPs)[6]. The PTA is evaluated by means of four CDPs: Kailua (Kailua-Kona area) and Kalaoa in North Kona, and Waikoloa Village and Waimea in South Kohala. The ratios derived from this source are considered baseline figures for the current analysis, as explained below.

On average, the PTA CDPs showed a daytime to resident ratio of 1.03 persons in 2000, suggesting some in-commuting during the day, especially to the Kailua-Kona area, whose two representative areas averaged 1.14. These figures do not consider the impact of non-Island residents such as visitors staying at area resorts.

[6] US Census Bureau, Census 2000, PHC-T-40, "Estimated Daytime Population and Employment-Residence Ratios: 2000" Journey to Work and Migration Statistics Branch, 2005.

These CDP derived figures are considered baseline indicators of daytime resident population in the PTA.

Commercial Supply in Relation to Population in 2010 (Exhibit 5-6)

Existing retail and office facilities in the PTA are compared to their relevant user populations in Exhibit 5-6.

- **Retail** GLA is compared to daytime population. The latter is estimated based on the above ratios for residents, adjusted as follows:
  - **Daytime residents** –Census data from 2000 shows the number of residents present during the daytime for every resident, within four finite CDPs situated in the PTA. In order to derive estimates of the daytime population within the PTA, the aggregate CDP ratio is increased by 20%, reflecting the larger population and larger number of employment sites located within the PTA as compared to the four CDPs. Hawaii Island residents present within the PTA during the daytime are thus estimated at 1.26 persons for every 1.00 persons who resided in the PTA in 2010, or 69,800 persons.
  - **Visitors** – An allowance for average daily visitors housed within each region is also added as a proxy for the number that might remain there during the daytime. This is based on Hawaii Tourism Authority data on numbers of visitor units, average occupancies and average party sizes. The PTA is thus estimated to have had some 18,600 visitors present on an average day in 2010.

    Utilizing these estimates, the PTA is seen to have offered about 30 square feet of retail area per daytime resident in 2010.

- **Office RBA** is compared to civilian employees residing in the PTA. The PTA's civilian labor force currently accounts for about 59% of its resident population, with insignificant variation between North Kona and South Kohala. The PTA housed a civilian labor force of some 32,400 persons in 2010, and therefore the area's 592,000 square feet of private office spaces represented 18 square feet per resident civilian employee[7]. The supply is relatively greater in North Kona than in South Kohala.

  With the job and career opportunities of the PTA, the area is likely to continue to attract a substantial workforce population, but its age profile will also "gray" as will the rest of the State's.

[7] This may be compared to 35 square feet per employee for Oahu as a whole in 2008.

Supportable Commercial Development in the Primary Trade Area (Exhibit 5-7)

Overview

Additional future retail-and office-based market needs will be related to growth in the daytime population of the PTA for retail space, and in the PTA's labor force for office space. The potentially rapidly increasing resident population of the PTA itself would anchor demand in the area. Additionally, the populations of rest of West Hawaii could also contribute significant retail expenditures to the PTA, as it becomes further established as the regional hub for jobs, services, entertainment and shopping. This analysis of supportable commercial area considers only demand that originates within the PTA, and thus may again be considered conservative.

Projected Demand

Assessment of projected supportable commercial areas in the PTA begins with resident population projections as developed previously in Chapter 2 for the CRMA. These figures are adjusted upwards to estimate population in the PTA with an expectation that the CRMA will become the dominant population center of the region over time. Hence the multiplier to adjust CRMA to PTA population declines over the study period, as it in fact has over the 2000 to 2010 period for which historical data or estimates are available.

Retail-based demand is evaluated as follows:

- This assessment assumes daytime to resident population ratio in the PTA rises from the 1.26 level that was derived for 2010 from year 2000 working patterns, to 1.30 by 2020 and 1.35 by 2030 and beyond. This is considered possibly conservative since the many proposed developments in North Kona reinforce its position as an employment and commercial hub of West Hawaii, and reflect its status as an urban development and infill area.

- Added to daytime resident population is an estimate of average daily visitors in the area. Visitor population is assumed to grow at 1.8% per annum in the future, including visitors staying in existing hotels and condominiums of the area, as well as those attracted to its increasing timeshare inventory.

- These components identify a future PTA retail consumer population of up to 225,800 persons by 2040, reflecting a 3.2% per annum rate of increase from 2010.

- In 2010, the PTA supplied 30 square feet per full-time equivalent (FTE) daytime person. However, after adjusting for the 10% retail vacancies observed in this year, the supportable GLA per person is estimated at 28 as of 2010. This assessment assumes a stagnant or gradually declining ratio of supportable area to population, recognizing ongoing changes in the nature of retailing.

- In conclusion, the PTA is estimated to support up to 6.1 million square feet of retail-based GLA by 2040.

Office-based demand is evaluated as follows:

- Future office-based demand is considered a function of growth in the civilian labor force in the PTA. This can be expected to follow from the establishment of a hospital at Kaloko Makai, relocation and expansion of UHCWH, additional job creation at NELHA and HOST, and from other plans for commercial, second home, and timeshare developments within the area.

- Some of these developments represent expansion of non-service industries and would support more professional and technical opportunities than are available today, leading to more office-based employment. Accordingly, supportable RBA in the PTA is projected to increase from about 16 in 2010 to up to 20 square feet per civilian employed resident.[8]

- Using these assumptions and considering just the PTA labor force as a demand generator, by 2040, the PTA could require up to 1.6 million square feet of office-based RBA.

Total Commercial Demand

In total, the retail- and office-market analyses indicate support for up to 4.8 million square feet of commercial area by 2020, or 7.7 million by 2040:

Projected Supportable Commercial Areas in the PTA (square feet)

	2020	2040
Retail-based demand	3,900,000	6,100,000
Office-based demand	900,000	1,600,000
Total	**4,800,000**	**7,700,000**

Note: Represents total projected supportable areas, including existing and entitled/planned developments. See Exhibit 5-7 for further information.

[8] As in the retail market, the estimated supportable area for 2010 is reduced from the actual supply, in recognition of currently high vacancies.

Assessment for Kaloko Makai (Exhibit 5-8)

Kaloko Makai Proposal

SCD-TSA proposes to offer up to 1,100,000 square feet of various commercial uses at Kaloko Makai. This would include spaces in shopping centers, mixed-use developments, medical-related and other office complexes. The majority is anticipated in the Project's transit-ready Urban Center (T5 zone) along Ane Keohokalole Highway. This area also includes the proposed medical center, so a portion of the commercial areas would be expected to be medical-support related. These areas could be expected to serve regional or even Island-wide markets, although the analyses undertaken herein were based on the PTA only.

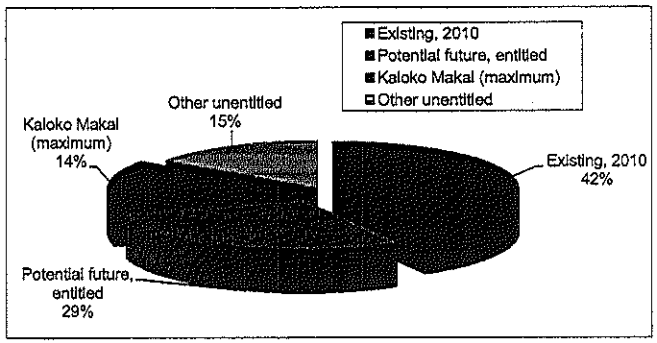
The remaining commercial areas could be within other General Urban areas of the Project (T4 zones). These supportive retail/shopping center areas would be expected to primarily serve community or neighborhood markets.

As for residential development, the first finished commercial building products at Kaloko Makai are assumed to be available for use in 2015.

Projected Supportable Commercial Areas

If developed to the full-proposed approximate capacity of 1.1 million square feet, Kaloko Makai's commercial spaces could represent some 14% of the PTA's total 2040 inventory. It could also represent a venue for about half of the currently unplanned but future supportable commercial space in the PTA.

Potential PTA Commercial Space Inventory: 2040



See Exhibit 5-8 for sources and further information.

6 – Light Industrial/Business Park Market Environment and Assessment

Background

Primary Trade Area

Light industrial areas can support business parks, manufacturing, energy production, research & development, wholesale, office, retail and other uses. They often serve a super-regional or Island-wide market. This analysis profiles market trends within the North Kona and South Kohala Districts, the same area referred to as the Primary Trade Area, or PTA, in the commercial market assessment. This is considered a conservative view of the potential market support for light industrial or business park areas at Kaloko since its market support might derive from a larger sphere than just the PTA.

Analytical Approach

This analysis does not consider industrial-uses or industrial-designated lands at military bases, harbors, universities or airports. Often such public lands tend to support heavy industrial or specialized public-purpose uses, which are not envisioned at the Project. Although a government entity, some of DHHL's holdings are counted here, however, because they are planned as income properties which would be leased to the general public.[1]

As in the residential and commercial analyses, the **supply** of light industrial land is evaluated in terms of existing properties that may already be in use and/or are being actively marketed, and State-entitled lands that could be developed in the future. The assessment is prepared in terms of land acres, with less attention paid to the market trends for development on such properties, such as warehouse occupancies and rents.

On the **demand** side, the long-term need for additional lands to be developed for light industrial or business purposes relates to trends in civilian job creation. Thus the analytical approach employed here is analogous to that employed in the office market assessment presented in the previous chapter.

[1] For instance, DHHL's proposed 152-acre property at Kalaoa is within the inventories used, with a share allocated to future commercial development and a share allocated to future light industrial inventories, based on representations made by DHHL. However, DHHL recently acquired another North Kona tract from the State and potential development on that property is not considered here, because the DHHL manager for this site indicated that there are no plans for these lands at the current time.

Industrial and Business Park Supply

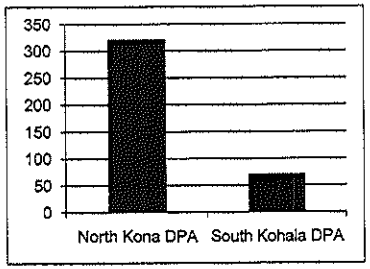
Area Inventory (Exhibit 6-1)

The light industrial lands of the PTA are concentrated in the North Kona DPA, which showed some 400 gross acres of light industrial lands as of December 2010. This represented 82% of the total PTA supply of 490 acres. The majority of these lands are located along Queen Ka'ahumanu Highway and adjacent to the Subject property, at Kaloko Industrial Park to its south and at Kohanaiki Industrial Park to its north. The other major existing industrial area of North Kona is the mature Kona Industrial Subdivision, developed by QLT and located next to Kailua-Kona Town.

Twelve percent of industrial lands remain unbuilt, according to County tax records. However a share of such "undeveloped" lands is known to be encumbered with ground leases and some are also in use, such as for yard space or surface parking.

Market trends for light industrial warehouse buildings reflect the current economic downturn that was also evident in the residential and commercial markets. The PTA as a whole showed about 15% of warehouse spaces vacant at year-end 2010, according to data provided by CMF. This is up significantly from an estimated 8% in 2008. However, positive space absorption is reported to have resumed in 2010. Net asking rents are available only for a sample of the North Kona properties. At an average $0.95 per square foot, those rents appear to have declined about 11% per annum since 2008.

Existing Industrial Lands
(in acres)



See Exhibit 6-1 for sources and further information.

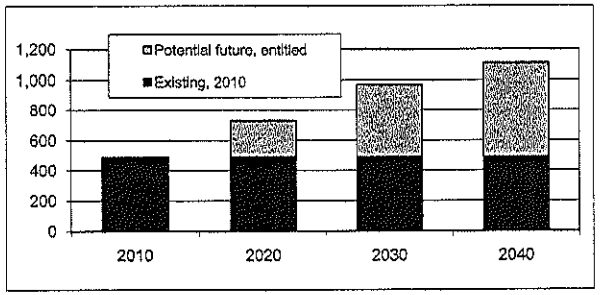
Planned Development and Future Inventory (Exhibit 6-2)

There were about 620 gross acres of land entitled and planned for business park/industrial use in the PTA as of December 2010, excluding lands at government-owned and operated facilities such as the Airport and harbors.

As in the existing inventory, the largest areas of entitled future inventory are also in the immediate vicinity of Kaloko Makai. These include West Hawai'i Business Park, Kaloko Industrial Park Phases III and IV, and DHHL's Kalaoa lands. The list of planned and entitled potential properties is presented in Appendix 5.

Considering the potential future developments plus areas already in use, the PTA could offer some 1,100 gross acres of private business or industrial park lands by 2040, assuming all future projects are developed to their estimated capacity and on the timetables projected. The majority of this inventory would remain in the North Kona District, surrounding the Project, on Queen Ka'ahumanu Highway.

Potential Future Industrial Land Inventory
in the PTA (gross acres)



See Exhibit 6-2 for sources and further information.

Industrial and Business Park Demand (Exhibit 6-3)

Demand for future business park/industrial lands in the PTA can be expected to originate from increases in civilian employment in the area, particularly in business and industrial categories such as energy production, construction, wholesaling and research & development.[2]

As public policy and private efforts promote economic transition to new industries in addition to tourism, one can expect to see the ratio of industrial space demand to employment continue to increase.

Of the 490 gross acres supplied in the PTA in 2010, 440 are estimated to have been occupied. This would mean that in 2010, there was excess supply compared to market demand amounting to about 10 acres.[3] Considering a 10% availability factor beyond occupied lands,

[2] Demand for new industrial properties can also be driven by transition mechanisms, such as when older industrial areas face urban redevelopment pressures. Such mechanisms may well come into play in West Hawaii during the study period, possibly because of transitions in the Kailua-Kona outskirts. However, they are not yet evident and so this potential source of additional demand has not been estimated.

[3] This is based on an assumed 10% of lands not in use. This benchmark is derived from the 12% of lands found to be without significant building improvements (based on tax records), less an allowance for undeveloped lands known to be encumbered or otherwise employed.

market balance in 2010 might have been satisfied with about 480 gross acres rather than the 490 that were in place[4]. This "desirable" level of supply would have represented 67 civilian employed persons per gross acre, as shown in Exhibit 6-3.

While this ratio could decline in the future if the island's economy becomes less service-oriented, for purposes of this assessment, we have held the ratio of employees per supportable gross industrial acre constant at 67. Given the projected rise in civilian employed persons in the PTA as discussed in Chapter 5, the PTA could be anticipated to support up to 1,180 gross acres of light industrial/business park lands by 2040. Subtracting the existing and entitled potential future supply, the area is seen to be able to support an additional 50 to 70 more acres of light industrial land over the study period, as shown in Exhibit 6-3.

Assessment for Kaloko Makai

Kaloko Makai Proposal

The Kaloko Makai plan designates 75 acres of light industrial or business park land uses in the Special District located at its makai end fronting Queen Ka'ahumanu Highway.

Approximately 25 acres of these lands have been identified by the State Department of Transportation (DOT) for a possible future public highway interchange at the entrance to the Project. Thus, industrial/business activity on those lands will be interim uses and only 50 gross acres are seen as long-term land uses.

Projected Supportable Areas

The Special District is an appropriate area for light industrial uses because:

- Light industrial uses would represent a relatively low-investment interim source of income from those lands that would ultimately be taken for public use as a highway interchange.
- The Special District is surrounded by other existing and planned light industrial land uses, at both Kaloko Industrial Park to its north, and West Hawai'i Business Park to its south.

[4] Significant other properties could have been brought to market if conditions warranted. For instance, the 41 net acres of Phase III of Kaloko Industrial Park, unsuccessfully marketed in 2009, are here considered part of the future, rather than the existing supply, because they do not appear to be actively marketed now. Thus, those 41 acres do not factor into the percent of undeveloped, existing lands as reported here.

- The general locale has been clearly established as a light industrial zone that serves regional and even Island-wide needs and benefits from its proximity to Keahole Airport, Honokohau Harbor and the well-developed visitor infrastructure of the region.
- Within Kaloko Makai, the Special District area is less attractive for residential and certain commercial uses because of its Waste Water Treatment Plant, its frontage along a very busy highway and the proposed interchange, and its relative lack of views due to its low elevation.

In conclusion, the Special District is considered a very appropriate area for light industrial/business park uses, and the lands set aside in the Kaloko Makai master plan are be supported by the area's market outlook, as follows:

Projected Demand for Additional Light Industrial/Business Park Lands in the PTA, cumulative gross acres

	2020	2030	2040	Comment
Unentitled demand*	50	50	70	See Ex. 6-3
Additional supply from Kaloko Makai				
New development	25	40	75	Timing of DOT interchange taking as depicted is illustrative only.
Less interchange	0	0	-25	
Net additional supply	25	40	50	
Remaining unmet demand	**25**	**10**	**20**	

* In addition to existing light industrial areas and all entitled and planned areas in the PTA. See Exhibit 6-3 for further information.
Source: Mikiko Corporation, 2011.

7 – Lodge and Business Center
Market Environment and Assessment

Background

Development Concept

The Kaloko Makai Lodge and Business Center is proposed to cater to the business and leisure demands generated by other uses in Kaloko Makai and its surrounding area. It is envisioned to offer up to 120-rooms, a business center, and meeting and conference spaces.

The Lodge and Business Center would be situated on approximately 5 acres of land within a T-5 zone located mauka of the Ane Keohokalole Highway.

Target Markets

While the Lodge and Business Center may attract leisure travelers to West Hawaii, its marketing focus is those who are in the vicinity because of other uses in the area, such as Kaloko Makai's medical facilities, judiciary complex, its residential community and the Kona Airport.

Target markets for the Kaloko Makai Lodge and Business Center could include:

- Primary targets:
  - Kama'ainas visiting family and friends in Kaloko Makai or neighboring areas;
  - Families and friends visiting or accompanying patients of the hospital;
  - Visiting medical staff involved with the hospital or related medical facilities;
  - Professionals and other parties to proceedings at the Kona Judiciary; and
  - Airline crews and commuters needing accommodations near to Kona Airport.
- Additional targets:
  - Other budget- and convenience-oriented travelers wishing to avoid the congestion, unneeded amenities and higher price points of resort areas; and
  - Athletic teams or other group travel seeking affordable and easily accessible accommodations away from resort the areas.

Conformance to Public Policy

Hawai'i County's economic growth during recent years has been closely tied to the visitor industry. However, as State and County policy makers seek to diversify their economic bases, new business and local service opportunities are highlighted.

The current County General Plan was developed under the assumption that the "County will continue to pursue the development of a strong multi-market base for the visitor industry that includes .... integrated product development for local products that can generate a healthy small business economic base. The County's visitor industry will continue to successfully grow and expand."[1]

Likewise, the Kona Community Development Plan provides for hotels and other lodging facilities within T5 zones such as proposed for Kaloko Makai.

The Lodge and Business Center at Kaloko Makai is planned to be in alignment with these goals and standards.

Analytical Approach

This chapter reviews general supply and demand indicators for visitor accommodations throughout the Island and in Kona. Due to the small size (up to 120 units, representing about a 1% addition to the Island inventory) and non-traditional market orientation of the proposed Lodge and Business Center, the assessment does not rely on a macro supply and demand assessment for the Island or region. Rather, the analysis considers visitor trends in the context of selected comparison hotel properties in Kona that appear to serve visitor markets such as those envisioned for Kaloko Makai.

Hotel Supply Market Conditions

Islandwide Hotel Inventory (Exhibit 7-1)

Just under half of the statewide visitor units in 2010 were located on O'ahu, according to a survey prepared for The Hawai'i Tourism Authority (HTA) by Hospitality Advisors, LLC. The island of Maui continued to have the second largest share of visitor units, followed by Hawai'i Island and Kaua'i.

Of Hawaii Island's 11,595 total visitor accommodation units, hotels continue to comprise the majority, or about 60% of units. While timeshare units are increasing most rapidly, they still represent only 16% of the Island's inventory.

[1] County of Hawaii, County of Hawaii General Plan, February 2005, pg.1-11.

More than half of the Island's visitor units cater to high-spending market segments, with 40% classified the Deluxe price class ($251 to $500 per room night) and another 14% in the Luxury class (more than $500 per room night).[2]

Kona Hotel Inventory and Selected Comparison Properties (Exhibit 7-2)

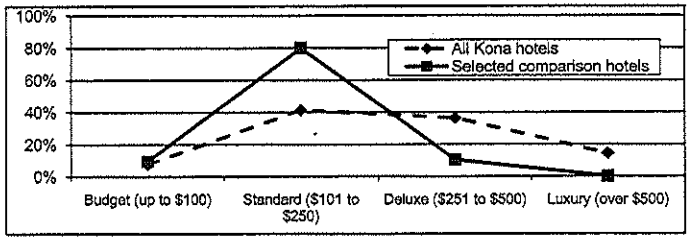
Within the Island inventory, the HTA distinguishes Kona visitor units from those in South Kohala and elsewhere on the Island. Focusing just on hotel properties, Kona showed 2,519 rooms in the 2010 inventory, with a similar price class mix as Island-wide: 51% are classified as Deluxe or Luxury units.

Although primarily targeting out-of-State leisure visitors, a handful of Kona hotels also cater to and attract a fair share of the interisland and value-oriented visitor base, particularly those not seeking a resort vacation experience. These include:

- King Kamehameha's Kona Beach Hotel (460 units),
- Kona Seaside Hotel (225 units),
- Royal Kona Resort (436 units), and
- Uncle Billy's Kona Bay Hotel (110 units).

The above hotels are considered the existing comparison set for the proposed Kaloko Lodge and Business Center. However, their characteristics are not necessarily conducive to the convenience- and/or business-oriented traveler that is envisioned at Kaloko. Other than Uncle Billy's Kona Bay Hotel, the properties are large (225 to 460 units), making rooms and facilities less readily accessible than possible in a significantly smaller property. All are located in relatively congested Kailua-Kona Town. In addition, despite recent renovations at the King Kamehameha, the comparison properties tend to be dated: opened between 1960 and 1975, they are now 36 to 51 years old.

Kona Area Hotel Unit Market Orientation



See Exhibit 7-2 for sources and further information.

[2] These standard rates are based on published or "rack" rates. Actual achieved room rates would be lower, on average.

What the selected properties do offer are favorable price points for the traveler who does not need a resort vacation experience and prefers convenience and value. Eighty percent of the combined room inventory is within the Standard class ($101 to $200 per room night), and another 9% is listed in the Budget class (up to $100).

Market Orientation of Selected Comparison Kona Hotels

	Budget (Up to $100 per night)	Standard ($101 to $250 per night)	Deluxe ($251 to $500 per night)	Luxury (Over $500 per night)
King Kamehameha's Kona Beach Hotel	0	460	0	0
Kona Seaside Hotel	116	109	0	0
Royal Kona Resort	0	306	128	2
Uncle Billy's Kona Bay Hotel	0	110	0	0
Total	**116**	**1,031**	**899**	**15**

Source: Hawaii Tourism Authority, 2010 Visitor Plant Inventory.

The proposed development at Kaloko Makai would offer a modern, purpose-built facility in a far more convenient location compared to these existing options.

Planned Competitive Hotels

The proposed Palamanui project, located north of the Kona Airport and Kaloko Makai, has also proposed a lodge, with some 70 units. It has been described as being oriented towards the university campus planned at Palamanui, but could also become competitive with some of the market segments targeted by the Kaloko Makai Lodge and Business Center.

There are no other known planned hotel projects in the North Kona or South Kohala areas at this time.

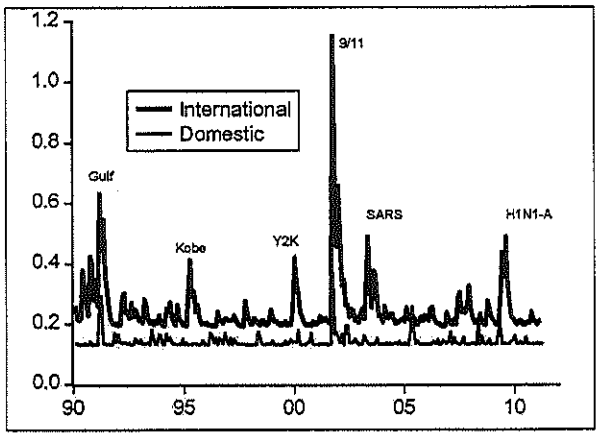
Demand Assessment

Statewide Trends

While Hawai'i hotel occupancy levels were starting to improve in 2010 and into early-2011, the March 2011 Japan earthquake, tsunami and subsequent aftermath, coupled with on-going global economic weaknesses, have renewed concern for the visitor and hotel industries.

However, Hawaii's experience with external shocks such as 9/11, various recessions, the Gulf War and SARS, has been a significant loss of visitor arrivals in the short-term, followed by recovery to more normal levels of volatility within a quarter or so. In particular, the domestic market has been far less sensitive to such events than the international arrivals market. This volatility relationship is reflected in 20 years of visitor arrivals data, as shown in the chart below, prepared by TZ Economics.

Volatility of Annualized, Seasonally-Adjusted Hawaii Visitor Arrivals



Source: TZ Economics, May 2011, reproduced with permission of the author. Raw data obtained from Hawaii Tourism Authority and Department of Business Economic Development and Tourism, seasonally adjusted with conditional estimates through March 2011.

Big Island Outlook

On the Big Island, where international arrivals represent just 12% of the market, industry recovery from the Sendai events is again expected to be full in the medium-term, and certainly by the time of first operations at the proposed Lodge and Business Center in 2015.[3] Barring sharp increases in fuel costs or other new shocks, the Economic Research Organization at the University of Hawaii (UHERO) forecasts increasing visitor arrivals to the Island, at +5.1% in 2011, +7.3% in 2012, and +3.4% in 2013.[4]

[3] Kona did experience direct tsunami damage related to the Sendai events. The 125-unit Kona Village Resort has closed permanently while the Four Seasons Resort Hualalai closed for six weeks for repairs, and reopened April 30, 2011.

[4] UHERO, "UHERO COUNTY FORECAST: Uneven Recovery Continues," May 20, 2011.

Airline seat capacity to Hawaii Island has experienced uncertainty but is showing particular strength from westbound routes. In October 2010, Hawaii Island lost its direct air service from Narita via Japan Airlines, but many of these seats were replaced the following month, when Alaska Airlines initiated nonstop service from Portland to Kona, adding to other new routes it had initiated previously in 2010.

Finally, recent HTA surveys concerning visitor satisfaction state that ratings by U.S. visitors who were very likely to recommend Hawai'i Island to family and friends for future travel improved to 79% (up 7 percentage points) in the third quarter of 2010. When visitors are highly satisfied with the destination they visited, they will be more likely to recommend the place to friends and family[5].

Kona Visitor Trends (Exhibit 7-3)

Exhibit 7-3 presents 2009 HTA data on out-of-State travelers to Kona. Selected statistics of particular interest to the market segments proposed for the Lodge and Business Center are:

- Kona area hosted 6.8 million visitor-days in 2009, of which 88% were domestic travelers and 12% international. This was down 6.4% from 2008.
- The average out-of-State traveler party size was 2.1 persons.
- 39% traveled on group, package or group & package arrangements, while 61% were "true independent" travelers.
- 49% stayed in hotels, while 9% stayed with friends or relatives, and 15% in a rental house, B&B or cruise ship.
- 14% traveled to conduct business (other than meetings, conventions and incentive business travelers, or MCI), visit friends and relatives, attend sporting events or for other miscellaneous purposes including those traveling on government, military or school business.

In context, this "non-pleasure" and "non-MCI" market could theoretically require some 1,000 accommodation units per day[6], a good share of which is likely to be with friends and relatives or in other nontraditional or noncommercial accommodations. However, the remainder of this sizeable market patronizes area hotels and other commercial accommodations for their overnight stays, and is representative of the markets being targeted by the Subject. Inter-island kama'aina business and other travelers are not counted in the HTA data and represent a significant expansion of this potential market.

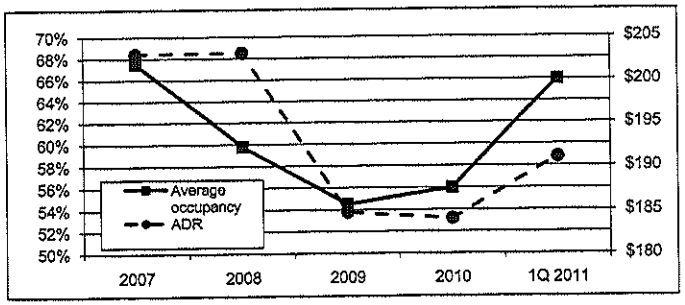
[5] HTA, 2010 Visitor Satisfaction Monitoring Report.

[6] Total visitor days of 6,796,000 x 14% market share x 6/7 (conversion of days to nights) / 365 days / 2.1 persons per room.

Area Hotel Market Trends (Exhibit 7-4)

Hotel occupancy and average daily rates on Hawai'i Island have typically lagged those for O'ahu and Maui and therefore the State as a whole. Within Hawaii Island, average occupancy rates ranging from 55% to 66% have been the norm in recent years, compared to 65% to 77% for the State as a whole. According to data from the Hawai'i Tourism Authority, 2009 reflected a slowing economy and a struggling visitor industry but the Island's 2010 numbers implied a rebound and the first quarter of 2011 continues the growth trend.

Island of Hawaii
Average Occupancy and Average Daily Room Rate



See Exhibit 7-4 for sources and further information.

In the first quarter 2011 report from Smith Travel Research and Hospitality Advisors, Hawai'i hotels experienced first quarter gains. While visitor arrivals from Japan were 13% higher through the month of February before dropping sharply following the March 11 earthquake and tsunami, arrivals from the Mainland and Canada pushed the overall market to positive territory during the quarter.

The average statewide hotel occupancy was 77%, up 6 percentage points compared to the first quarter of 2010. The average daily room rate was $191, up 9% from last year, and revenue per available room, or RevPAR, was $147, up 19% from a year ago.

The Big Island's occupancy rate was 66%, up 10 percentage points, and its average daily room rate was $191, up 2%. RevPAR for the Big Island was $126, up 18% from last year.

Assessment for Kaloko Makai

Suggested Facilities and Amenities

Based on the target markets identified at the start of this chapter, the Kaloko Makai Lodge and Business Center is proposed as a relatively compact, efficient property of 120 or fewer rooms. Rooms may tend to be larger than typical at a tourist-oriented hotel, to accommodate larger travel groups, and work areas. It would likely also offer common amenities such as a front desk, swimming pool and/or workout facility, and on-site parking.

An integral component will be the Business Center. The Business Center could provide "an office away from home," with a range of services and amenities such as:

- Conference or meeting rooms
- Copying, scanning and digital printing services
- High-speed internet and Wi-Fi access
- Equipment rentals
- Videoconferencing
- Courier delivery services
- Send and receive e-mail and facsimiles
- Full range of ground and express shipping services
- Notary service

Projected Lodge Market Performance

The Kaloko Makai Lodge and Business Center concept is to focus on local, business and other market sources that seek convenient access and value-based rates over resort and recreational facilities. Currently, such markets must find accommodations in aging tourist-oriented hotel facilities in relatively congested Kailua-Kona or in nontraditional or non-commercial (such as with friends and family) venues. Despite their age, standard room rack rates at the comparison hotel properties are generally priced from about $100 to $170, with achieved rates perhaps 20% to 40% lower.

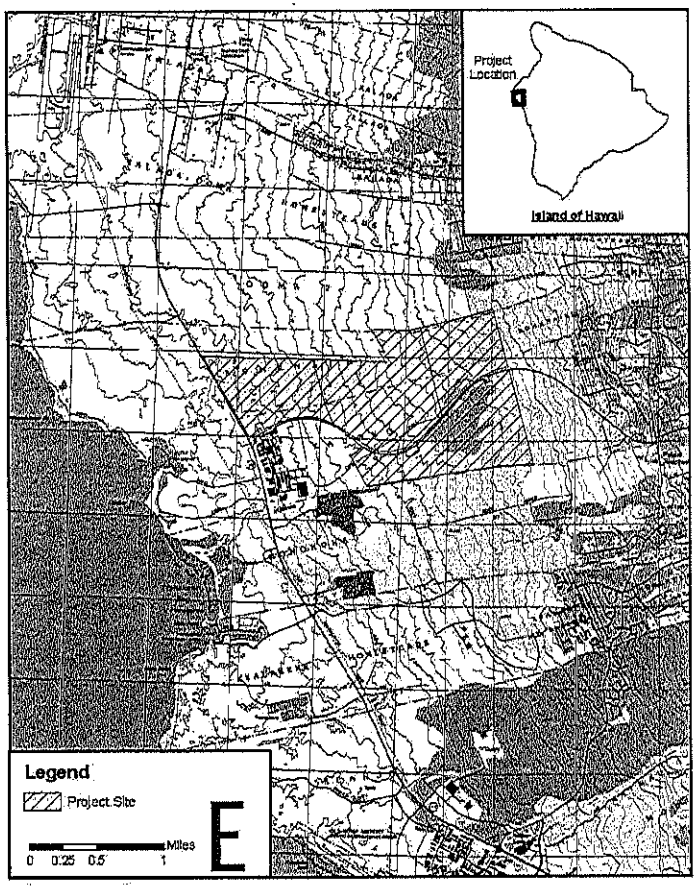
Based on these comparisons, the Kaloko Makai Lodge and Business Center is estimated to achieve an average daily room rate of about $120 to $130 at stabilization. This considers that it would be a modern, purpose-built and conveniently located facility, better suited to its targeted markets than existing options, and possibly competitive with a future lodge facility at Palamanui.

Given its small size and the potential size of the relatively underserved kama'aina and business market segments targeted, average annual occupancy at the Kaloko Makai Lodge and Business Center is projected at 65% at stabilization.

Market Assessment for Kaloko Makai

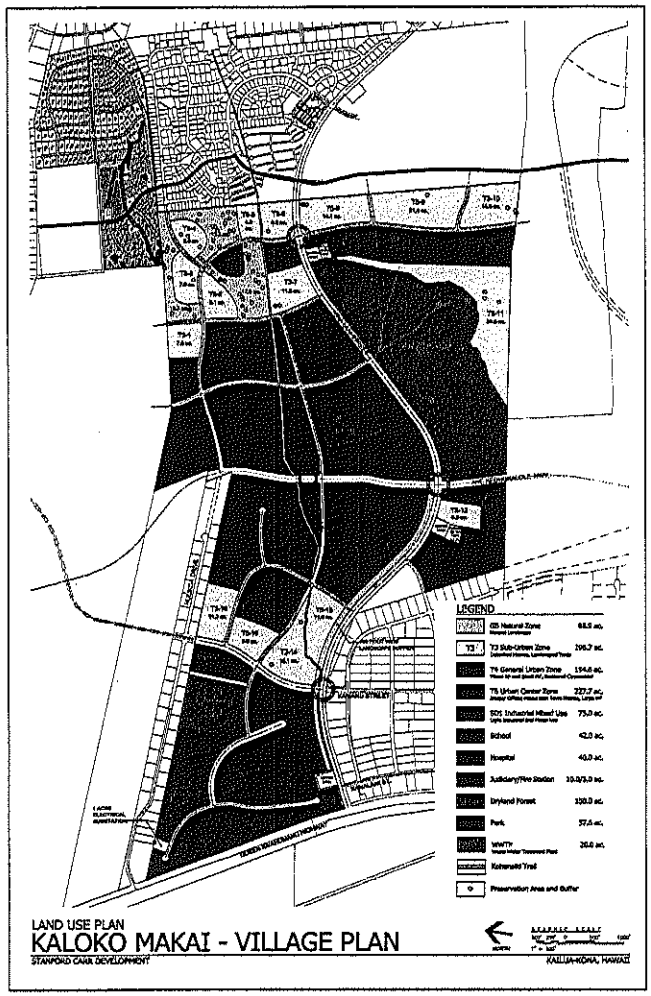
Exhibits

Exhibit 1-1
Kaloko Makai – Site Location



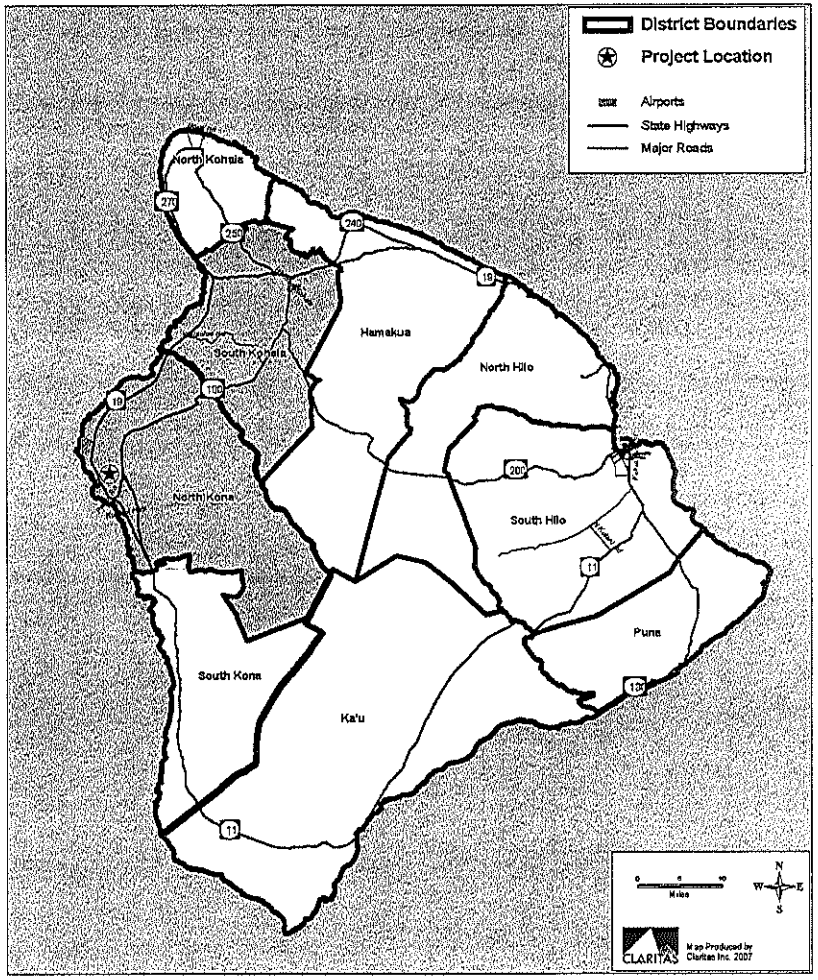
Source: SCD-TSA Kaloko Makai, LLC, 2011.

Exhibit 1-2
Kaloko Makai – Conceptual Land Use Plan



Source: SCD-TSA Kaloko Makai, 2011.

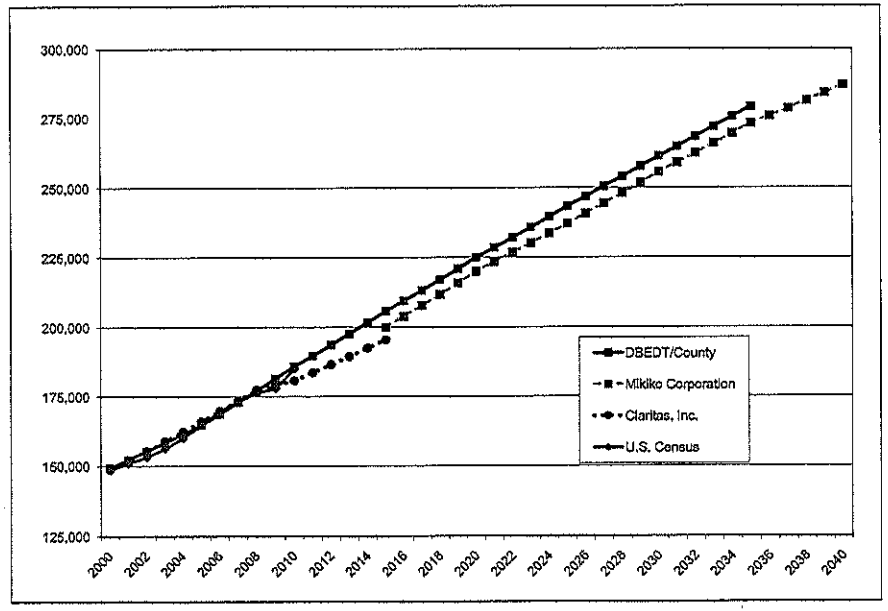
Exhibit 2-1
Kaloko Makai Location and Hawaii Island Districts



Source: Claritas, Inc., October 2007.

Exhibit 2-2
Resident Population - Island of Hawaii
Comparison of Estimates and Projections
2000 to 2040

	Date of study	2000	2010	2015	2020	2030	2040	Average annual growth 2000-2010	2010-2020	2020-2030	2030-2035	2035-2040
DBEDT/County[1]	2008	149,261	185,850	205,820	225,000	261,340	INA	2.2%	1.9%	1.5%	1.3%	NA
Mikiko Corp.[2]	2010	INA	INA	200,000	220,100	255,800	286,900	INA	1.9%	1.5%	1.3%	1.0%
Claritas[3]	2010	148,677	180,820	195,460	INA	INA	INA	2.0%	INA	INA	INA	INA
U.S. Census[4]	2010	148,677	185,079	INA	INA	INA	INA	2.2%	INA	INA	INA	INA



INA - information not available.

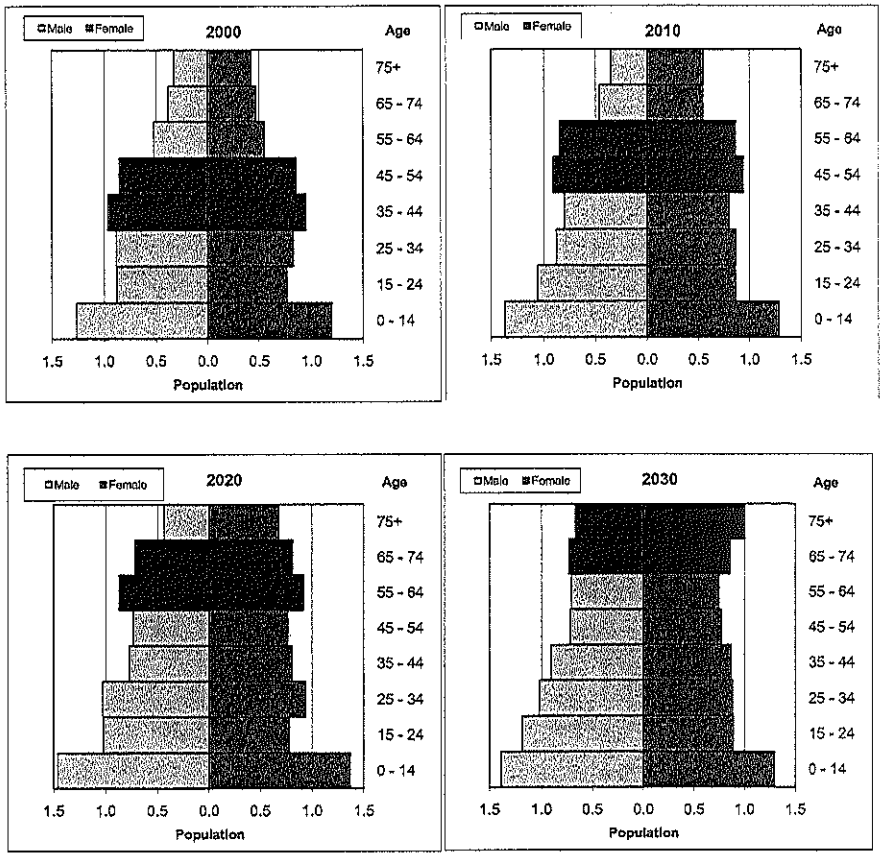
1 State of Hawaii, Department of Business, Economic Development and Tourism, Research and Economic Analysis Division, "Population and Economic Projections for the State of Hawaii to 2035," (DBEDT 2035 Series), January 2008. Actual and estimates through 2007; projections thereafter presented in 5-year increments. Figures interpolated by Mikiko for years in-between. County indicates that it has adopted DBEDT's projections.

2 Projections prepared by Mikiko assuming 2015 population at approximately midpoint of Claritas (2010) and DBEDT/County (2008) projections for that year. Projections thereafter based on DBEDT/County projected rates of growth to 2035 and an assumed declining rate thereafter as shown.

3 Claritas, Inc., October 20, 2010; estimate for 2010, projection for 2015, figures interpolated in-between. 2000 to 2009 data shown are estimates prepared by Claritas in previous years.

4 U.S. Census Bureau, 2011, Summary File, Table P1; Ibid, Population Division, "Table 1. Annual Estimates of the Resident Population for Counties of Hawaii" April 1, 2000 to July 1, 2009," (CO-EST2009-01-15) March 2010.

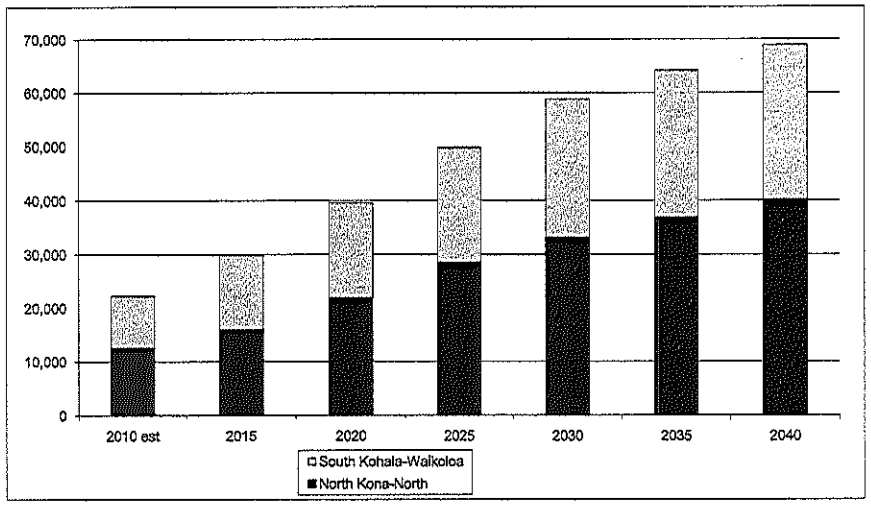
Exhibit 2-3
Projected Population by Age Group - State of Hawaii
2000 to 2030



Notes: Each unit on the X axis represents 100,000 persons. Highlighted bars include the Baby Boom cohort.
Source: U.S. Census Bureau, Population Division, Interim State Population Projections (released 4/21/05), http://www.census.gov/population/www/projections/statepyramid.html.

Exhibit 2-4
Resident Population -
Competitive Residential Market Area and Island of Hawaii
2010 to 2040

	2010 Census/ Estimate	2015	2020	2025	2030	2035	2040	Average annual % increase, 2010-40
Competitive Residential Market Area[1]:								
North Kona-North[2]	12,641	16,000	22,000	28,500	33,200	36,900	40,200	3.9%
South Kohala-Waikoloa[3]	9,675	14,000	17,600	21,300	25,600	27,300	28,700	3.7%
Total CRMA	22,300	30,000	39,600	49,800	58,800	64,200	68,900	3.8%
Island of Hawaii[4]	185,079	200,000	220,100	237,200	255,600	273,000	286,900	1.5%
As a percentage of island:								
North Kona-North[2]	6.8%	8.0%	10.0%	12.0%	13.0%	13.5%	14.0%	
South Kohala-Waikoloa[3]	5.2%	7.0%	8.0%	9.0%	10.0%	10.0%	10.0%	
Total CRMA	12.0%	15.0%	18.0%	21.0%	23.0%	23.5%	24.0%	



[1] As provided by Claritas for 2008. Thereafter, population projected by Mikiko Corporation assuming CRMA's share of island population should approach alignment with the area's relative share of its jobs base (21% in 2006, 23% in 2010) within the projection period.

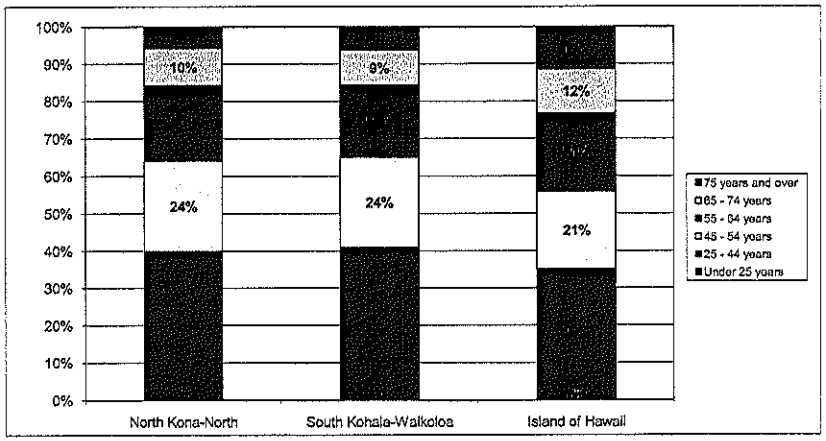
[2] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

[3] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

[4] DBEDT/County series to 2035, with Mikiko Corporation extrapolation to 2040, as shown in Exhibit 2-2.

Exhibit 2-5
Households by Age of Household Head
Competitive Residential Market Area and Island of Hawaii
2010 Estimate

	North Kona-North[1]	South Kohala-Waikoloa[2]	Island of Hawaii	As a percentage of Island of Hawaii: North Kona-North[1]	As a percentage of Island of Hawaii: South Kohala-Waikoloa[2]
Under 25 years	140	169	2,237	6%	8%
25 - 44 years	1,542	1,317	21,046	7%	6%
45 - 54 years	1,022	875	13,853	7%	6%
55 - 64 years	844	697	13,760	6%	5%
65 - 74 years	423	339	7,850	5%	4%
75 years and over	243	229	7,603	3%	3%
Total	4,214	3,626	66,349	6%	5%
Median age	**34**	**37**	**52**		



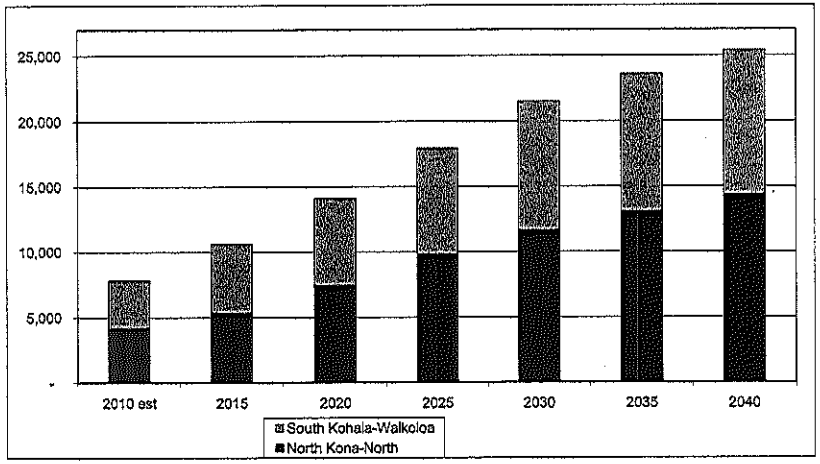
[1] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

[2] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

Source: Claritas, Inc., October 20 and 25, 2010.

Exhibit 2-6
Households - Competitive Residential Market Area and Island of Hawaii
2010 to 2040

	2010 Estimate	2015	2020	2025	2030	2035	2040	Average annual % increase, 2010-40
Number of households:[1]								
Competitive Residential Market Area -								
North Kona-North[2]	4,210	5,350	7,460	9,830	11,650	13,090	14,360	4.2%
South Kohala-Waikoloa[3]	3,620	5,240	6,640	8,130	9,850	10,500	11,040	3.8%
Total CRMA, rounded	7,800	10,600	14,100	18,000	21,500	23,600	25,400	4.0%
CRMA as % of Island	*11%*	*14%*	*17%*	*20%*	*22%*	*23%*	*23%*	2.4%
Island of Hawaii	69,100	74,600	83,100	90,200	97,600	104,200	109,500	1.5%
Average household size:[4]								
North Kona-North[2]	3.00	2.99	2.95	2.90	2.85	2.82	2.80	-0.2%
South Kohala-Waikoloa[3]	2.67	2.67	2.65	2.62	2.60	2.60	2.60	-0.1%
Island of Hawaii	2.68	2.68	2.65	2.63	2.62	2.62	2.62	-0.1%



[1] As provided by Claritas for 2010. Thereafter, based on projected population as shown in Exhibit 2-4 and household sizes as shown.

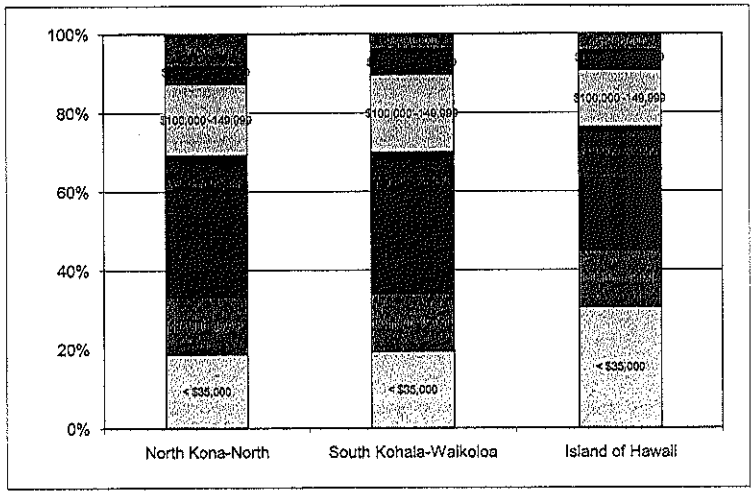
[2] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

[3] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

[4] As provided by Claritas for 2010, with only nominal declines to 2015 as economic conditions solidify. Thereafter, household sizes projected to decline at a diminishing rate. Household sizes within CRMA projected to approach those of County over time.

Exhibit 2-7
Households by Household Income - Competitive Residential Market Area and Island of Hawaii
2010 Estimate

	North Kona-North[1]	South Kohala-Waikoloa[2]	Island of Hawaii
Median household income	$69,958	$69,169	$67,237
Per capita income	$31,529	$32,050	INA
Number of households, by income -			
Less than $34,999	787	702	20,322
$35,000 - $49,999	606	528	9,334
$50,000 - $74,999	894	760	12,398
$75,000 - $99,999	634	552	8,637
$100,000 - $149,999	758	708	9,504
$150,000 - $199,999	194	241	3,376
$200,000 or more	341	135	2,778
Total	4,214	3,626	66,349



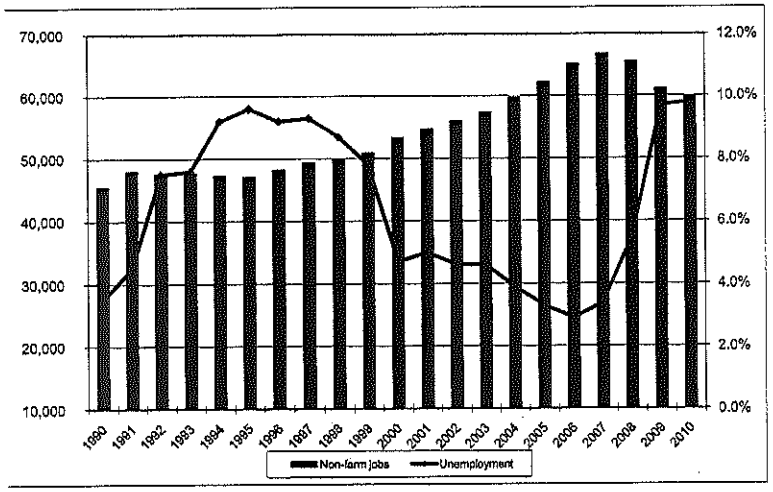
[1] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

[2] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

Source: Claritas, Inc., October 20 and 25, 2010.

Exhibit 2-8
Labor Force Trends - Hawaii County
1990 to 2010

	Civilian labor force	Employed persons	Non-farm wage & salary jobs	Percent unemployment
1990	58,350	56,300	45,500	3.5%
1995	65,400	59,100	47,100	9.6%
2000	74,200	70,750	53,300	4.7%
2005	81,850	79,150	62,200	3.3%
2006	85,050	82,550	65,150	2.9%
2007	85,750	82,850	66,800	3.4%
2008	86,650	81,850	65,550	5.5%
2009	84,250	76,100	61,100	9.7%
2010	83,250	75,150	59,900	9.8%



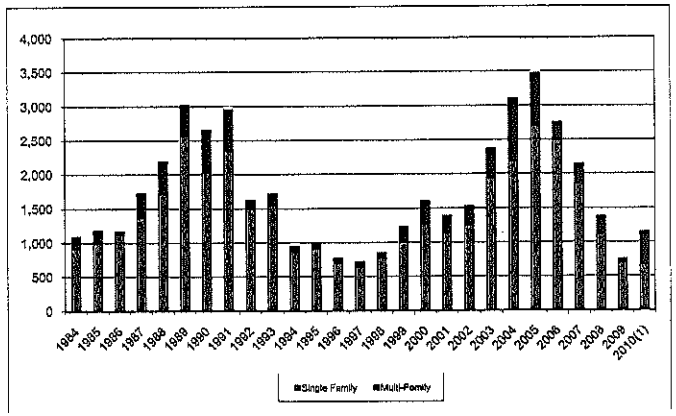
Source: "Hawaii State Department of Labor & Industrial Relations, 2007. Labor force estimates revised by DLIR with new methodology employed by U.S. Bureau of Labor Statistics, as of 2007. As referenced in: www.hiwi.org/admin/uploadedPublications/470_LFHC.PDF, www.hiwi.org/admin/uploadedPublications/1019_URATE.current.pdf and www.hiwi.org/analyzer/qslabforcedata.asp?cat=HST_EMP_WAGE_LAB_FORCE&session=LABFORCE&subsession=99&areaname=.

Non-farm wage and salary job estimates provided by DLIR as referenced in www.hiwi.org/admin/uploadedPublications/700_CESHC00S.PDF and http://www.hiwi.org/gsipub/index.asp?docid=421.

State of Hawaii, Department of Labor and Industrial Relations, Research and Statistics Division, March 2011.

Exhibit 3-1
Residential Building Permits - County of Hawaii
1990 - 2010[1]

	Single Family	Multi-Family	Total
Average	**1,484**	**321**	**1,805**
1990	2,024	627	2,651
1995	908	90	998
2000	1,260	347	1,607
2005	2,698	771	3,469
2006	2,484	270	2,754
2007	1,851	291	2,142
2008	1,108	270	1,378
2009	694	58	752
2010[1]	667	482	1,149



Not seasonally adjusted.

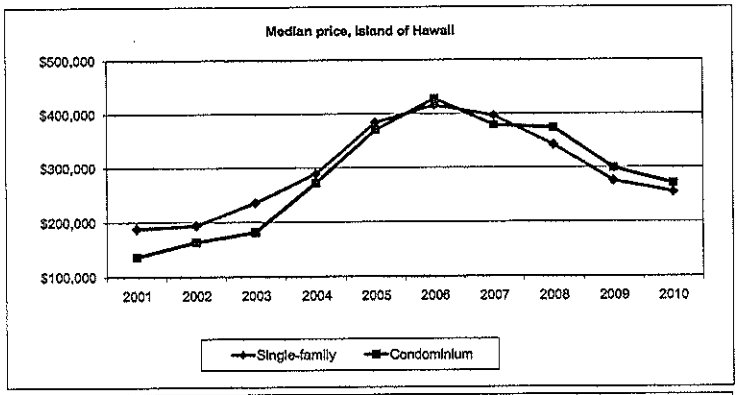
[1] Annualized based on data through November 2010.

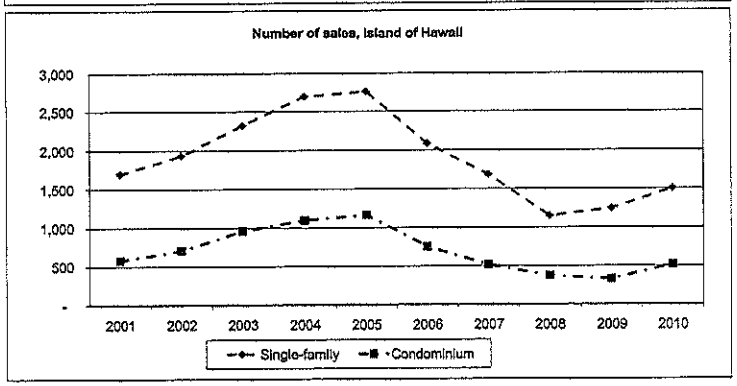
Sources: "Hawaii County Data Book Section 16: Construction & Housing." www.co.hawaii.hi.us/databook_current/section16.htm, date last modified 04/23/2010; Hawaii County, Department of Public Works http://www.hawaii-county.com/permits/2010permits.html.

County of Hawaii: Department of Research & Development - County of Hawaii Statistics; http://www.hawaii-county.com/info/stats/nov10.pdf

Exhibit 3-2
Hawaii County Residential Resales Trends
2001 to January 2011

	2001	2005	2006	2007	2008	2009	2010	Jan 2011	(compared to Jan 10)
Median price -									
Single-family	$188,400	$383,800	$416,100	$396,400	$342,400	$275,000	$255,000	$220,000	-6%
Condominium	$137,100	$370,600	$428,200	$379,100	$373,600	$299,000	$270,000	$219,000	-18%
Number of sales -									
Single-family	1,696	2,757	2,083	1,684	1,147	1,246	1,503	103	+17%
Condominium	580	1,166	750	517	371	328	519	43	+48%

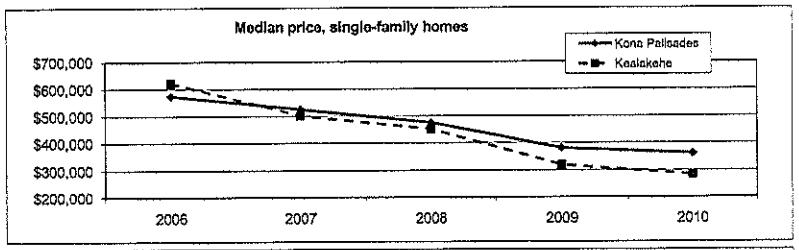


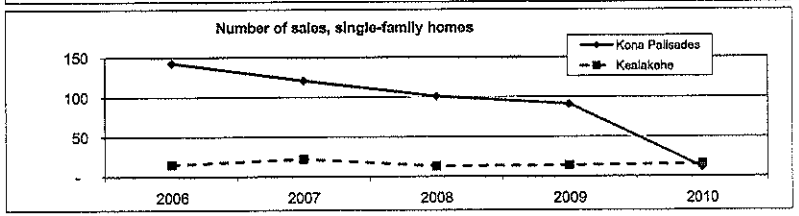


Source: University of Hawai'i Economic Research Organization, Economic Information Service.

Exhibit 3-3
Residential Sales in Kona Palisades and Kealakehe
TMKs 3-7-3 & 4, North Kona-North
2006 to 2010[1]

	2006	2007	2008	2009	2010[1]	Average annual percent change
Kona Palisades:						
Median price -						
Single-family	$575,000	$525,000	$475,000	$380,000	$360,000	-11.0%
Condominium[2]	$572,500	$293,403	$293,403	$399,950	$325,000	-13.2%
Number of sales -						
Single-family	143	121	101	91	154	1.8%
Condominium	16	35	14	18	11	-9.4%
Kealakehe:						
Median price -						
Single-family	$622,000	$502,000	$450,000	$318,700	$284,000	-17.8%
Condominium	$975,000	$600,000	–	$580,000	–	INA
Number of sales -						
Single-family	15	22	13	14	16	1.0%
Condominium	13	3	0	4	0	INA





[1] Based on 2010 sales data through October; median price based on 10 months data; number of sales annualized. Figures not seasonally adjusted.

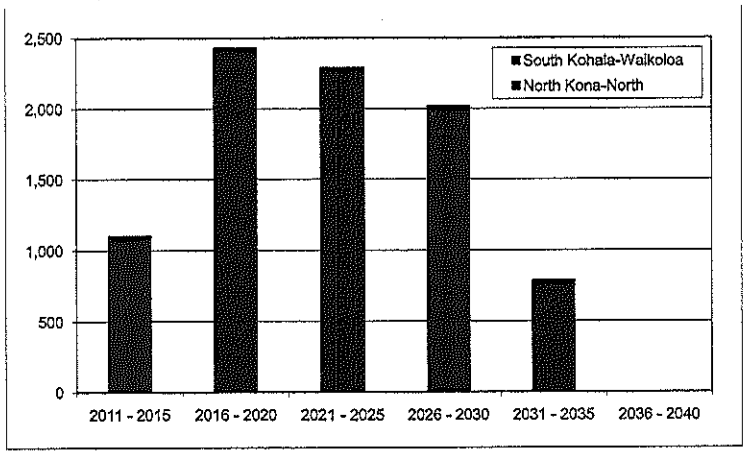
[2] Median prices for 2007 and 2008 are identical because they represent same floor plan developer sales by Seascape Development LLC.

Note: Kona Palisades and Kealakehe neighborhoods evaluated based on recorded residential sales within Tax Map Keys 3-7-3 and 4, respectively, but excluding properties makai of Queen Kaahumanu Highway, west of Palani Road and *mauka* of Mamalahoa Highway.

Source: Hawaii Information Service, data as of November 4, 2010.

Exhibit 3-4
Potential New Resident Housing Units - Competitive Residential Market Area
Based on Planned Developments with State Entitlement or Exemption as of December 2010

	2011 - 2015	2016 - 2020	2021 - 2025	2026 - 2030	2031 - 2035	2036 - 2040	Total, rounded
North Kona-North[1]	660	1,700	1,770	1,570	600	0	6,300
South Kohala-Waikoloa[2]	440	730	520	450	190	0	2,300
Total (rounded)	1,100	2,430	2,290	2,020	790	0	8,600
% of projection period	13%	28%	27%	23%	9%	0%	100%
cumulative %	13%	41%	68%	91%	100%	100%	



[1] Census Tract 215.01, the northern part of the North Kona District, generally to Henry Road. Excludes Kailua-Kona and areas southward. See Appendix 1 for map.

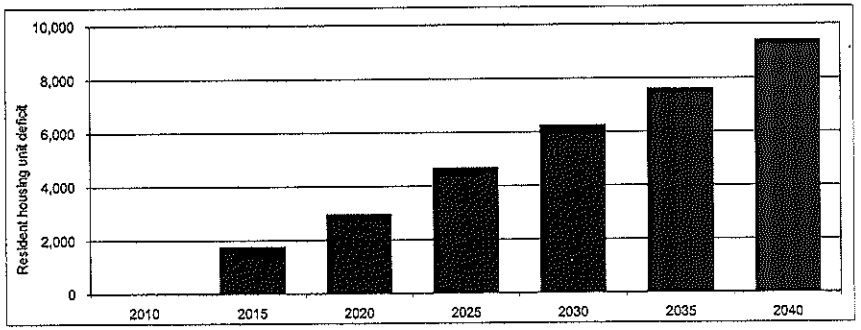
[2] Census Tract 217.01, the southern part of the South Kohala District, generally from Waikoloa Beach Resort to Mauna Kea Resort, and mauka to Waikoloa Village. Excludes Waimea Town. See Appendix 2 for map.

Note: Survey targeted projects of 100 units or more. Excludes emergency shelters, dormitory beds and other group living quarters.

Sources: Interviews with developers, landowners and project principals as shown in Appendix 3. Component numbers may vary slightly from those in Appendix 3 due to rounding.

Exhibit 3-5
Projected Supply and Demand for Housing - Competitive Residential Market Area
2010 to 2040

	Basis/ reference	2010	2015	2020	2025	2030	2035	2040	Total/ average, 2010-2040
Demand (households):									
Number	Exhibit 2-6	7,800	10,600	14,100	18,000	21,500	23,600	25,400	
Change since prior date -									
Total (rounded)		--	2,800	3,500	3,900	3,500	2,100	1,800	17,600
Average annual		--	560	700	780	700	420	360	590
Supply (resident housing units):									
Estimated occupied housing units in 2010[1]	Claritas/ Mikiko	7,800							
Entitled new developments - Potential development since prior date (total rounded)	Exhibit 3-4	--	1,100	2,430	2,290	2,020	790	0	8,600
Less vacancy allowance (applied to new units, rounded)	5%	--	-60	-120	-110	-100	-40	0	-430
Net available RHUs (rounded)		7,800	8,840	11,150	13,330	15,250	16,000	16,000	8,200
Change since prior date -									
Total		--	1,040	2,310	2,180	1,920	750	0	8,200
Average annual		--	210	460	440	380	150	-	270
Resident housing unit surplus/(deficit):									
At prior date shown[2]		INA	0	(1,760)	(2,950)	(4,670)	(6,250)	(7,600)	
Net surplus (deficit) in RHU production since prior date[2]		INA	(1,760)	(1,190)	(1,720)	(1,580)	(1,350)	(1,800)	
By end of column date		0	(1,760)	(2,950)	(4,670)	(6,250)	(7,600)	(9,400)	



INA = information not available RHU = resident housing unit (for full-time residents)

[1] Estimated based on total less vacant housing units as estimated by Claritas for 2010, as of October 2010. Figure includes occupied vacation or seasonal homes and thus is considered an overestimate of available RHUs. See beginning of Chapter 3 text for discussion.

[2] Unmet market demand (vs. desires) assumed to be 0 in 2010 due to prevailing soft economic conditions and relatively high primary residential vacancies compared to historical trends.

Exhibit 4-1
Performance Indicators for Selected Comparison Residential Projects
Comparison to Kaloko Makai market unit plans

Kaloko Makai Transect Zone	Permitted uses[1]: Building types	Permitted uses[1]: Density and story height	Preliminary SCD plans/ densities - market units	Comparison projects: Name, location (developer)	Density (U/A)	Recent price indicators[2]: 2008 - 1Q 2009	Recent price indicators[2]: 2010	Developer sales[3]		Comments
Urban, T4 and T5	Townhouses, apartments, or SF condominiums; may be mixed with retail or office uses	Up to 12 (for T4) or 30 (for T5) units/acre; 1- to 5-stories	Multifamily, 7 to 13 units per acre	Makana Kai, Wehilani, Waikoloa Village (Castle & Cooke)	12	$225,000 to $295,000; $255,700 average	$85,000 to $306,000; $191,000 average[4]	50/ year	2007, at $337,000-$400,000+	4- and 6-plex THs, marketed 2/2006 to 12/2009. 80% primary residential.
				Alii Cove, Kailua-Kona (Sunstone Realty Partners X LLC)	11	$200,000 to $595,000; $426,658 average	$233,500 to $415,000; $305,667 average	70-110/ year	2005-2006, at $365,000-$400,000 average	Mauka side of Alii Drive; first marketed late 2004, 200 total units. Transient rentals permitted.
				Alii Park Place, Kailua-Kona (Alii Park Place LLC)	11	$360,000 to $492,153; $414,593 average	$265,000 to $385,000; $330,819 average	20 & 40/ year	2004-2005, at $370,000 & $460,000 averages	Mauka side of Alii Drive; first marketed in 2004, 59 total units. Transient rentals permitted.
				Pines at Kailua-Kona I and II, North Kona-South (Taiyo Hawaii Co., Ltd.)	7	$270,000 to $490,000; $369,000 average	$221,000 to $362,500; $276,870 average	NA	resales	191 units built 1989 & 1990. SFD condos/ZLL; 3,000 to 5,000 sf lots; ocean views from many.
Suburban, T3	SFD or duplex	Up to 6 units/acre; 1-2 stories	Single-family, 3 to 6 units/acre	Pualani Estates, North Kona-South (DR Horton-Schuler Division)	4	$380,000 to $627,000; $459,000 average	$314,900 to $527,732; $403,273 average	50-70/year[5]	2004 to 2008 at $327,000 to $557,000 average	Average 6,000 sf lots, range 5,000 to 8,000, with homes 1,140-1,699 sf. First sales in 2004.
				Kikaha, Wehilani, Waikoloa Village (Castle & Cooke)	3	$379,000 to $450,000; $424,000 average	$350,000 to $568,000; $453,000 average	20/year	9/2008-6/2009, at $425,000 average	SFD - 36 homes and 18 vacant lots, average 10,000 sf.

[1] Place Makers, LLC, "Kona Village Design Guidelines" (calibrated for County of Hawaii), Final Draft, October 10, 2010. Density expressed in units per gross acre (including throughfares but excluding civic zones such as trails, plazas, playgrounds, etc.)

[2] Current asking prices for projects in marketing; recorded sales prices from 1/1/08 to 4/15/09 and 1/1/10 to 12/31/10 for projects with recorded sales; projected sales prices for planned developments. Excludes pricing of affordable units within projects, where applicable.

[3] Range of average annual sales during years of substantial developer inventory; years specified.

[4] All 5 transactions appear to represent bank foreclosures and subsequently discounted REO sales, and so are considered less representative; no developer sales.

[5] Rate applies except in 2006, when only 19 developer sales recorded.

NA - Information not available; MF - multifamily homes; SFD - single-family detached homes; TH - townhouse; U/A - units per gross acre.

Sources: Interviews with developers and other project representatives; project websites; Hawaii Information Service; Pacific Business News; Honolulu Star Advertiser.

Exhibit 4-2
Residential Market Assessment for Kaloko Makai
2010 Dollars

Unit type/area	Number of units	Example densities (U/A)	Average annual absorption rate[1]	Average unit sales price	Potential marketing period (years)
Affordable homes (T5)	700	13 to 17[2]	28	$284,500[2]	25
Market homes:					
T5 - Multifamily	2,274	7 to 13	88	$345,000	26
T4 - Multi- or single-family	1,206	7 to 8	50	$390,000	24
T3 - Single-family	820	3 to 6	35	$475,000	23
Subtotal/average, market homes	4,300	3 to 13	166	$382,000	26
Total/average, all products (rounded)[3]	**5,000**	**3 to 17**	**190**	**$369,000**	**26**

1 Total assumes several but not all products are marketing simultaneously; therefore it may be less than sum of average absorption of individual product types.

2 Affordable unit count based on 5,000 total units generating 1,000 affordable housing credits, and County rules regarding assignment of credits on for-sale units by income range of buyers. See Hawaii County Code, Chapter 11, Section 11-5 (amended 2011.) If additional housing credits are required to address nonresidential units at Kaloko Makai, developer will comply with such requirements.
For illustrative purposes, Hawaii County guidelines in effect as of September 1, 2010 would specify for-sale housing offered to households of two to four persons earning incomes ranging from less than 80% and up to 120% of the County median income be priced from $202,500 to $368,200; figure shown is based on a mix of market orientations that would satisfy the 1,0000 credits expected to be required of the developer.
Price guidelines also specify one- to two-bedroom rental units offered to households earning 80% to 100% of median income be priced from $1,037 to $1,500 per month, including utilities, County of Hawaii, Office of Housing and Community Development, "Affordable Housing Guidelines for the County of Hawai'i."

Actual inventory, unit types and tenure of affordable housing to be determined in future agreements with government agencies.

Exhibit 4-3
Kaloko Makai - Potential Residential Sales Absorption By Unit Type
Based on maximum development scenario and no rentals

Unit type/area	Maximum units	Average annual absorption rate	2015 - 2020	2021 - 2030	2031 - 2040
Number of years in period			6	10	10
Affordable homes[1]	700	28	168	280	252
Market homes	4,300	166	998	1,638	1,664
Total Project[2]	5,000	190	1,166	1,918	1,916

1 Based on requirement for 1,000 affordable housing credits and variable scale of satisfying those credits by unit type, as specified by County affordable for-sale housing rules as amended in April 2011. Actual inventory mix and unit tenure to be determined in future agreements with government agencies. (See note on Exhibit 4-2.)

2 Total assumes several but not all products are marketing simultaneously; therefore it may be less than sum of average absorption of individual product types.

Exhibit 5-1
Existing Retail Supply and Market Indicators - Primary Trade Area
In square feet, as of December 2010

	North Kona[1]	South Kohala[2]	Total PTA
Gross leasable area	1,937,000	676,000	2,613,000
Vacancy indicators[3]	10%	11%	10%
Largest properties	Kona Commons including Target (505,000)	Parker Ranch Center (146,800)	Kona Commons including Target (505,000)
	Makalapua Shopping Center (170,000)	Queen's Marketplace (135,000)	Makalapua Shopping Center (170,000)

Note: Excludes retail uses in light industrial or business centers. Includes some office/service tenants within shopping centers or other primarily retail complexes.

1 Defined as Census Tracts 215.01, 215.02, 215.03, 216.01 and 216.02.

2 Defined as Census Tracts 217.01 and 217.02.

3 PTA vacancies based on survey by Colliers Hawaii Consulting in November 2010, with sample representing approximately 88% of the PTA's GLA.

Sources: Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc., custom and proprietary reports, 2010. Pacific Business News, "Book of Lists 2010," 2010.

Exhibit 5-2
Existing Office Supply and Market Indicators - Primary Trade Area
In square feet, as of December 2010

	North Kona[1]	South Kohala[2]	Total PTA
Rentable building area (rounded)	529,000	63,000	592,000
Vacancy indicators	18%	21%	18%
Largest properties/areas (Rentable building area)	The Pottery Terrace (47,500)	Waikoloa Highlands Center (19,900)	The Pottery Terrace (47,500)
	Kaiwi Square (37,600)[4]	Kamuela Business Center (18,400)	Kaiwi Square (37,600)[4]

Note: Excludes government-owned buildings and some exclusively owner-occupied buildings. Properties may also house some retail spaces, not included in retail inventory on previous exhibit.

[1] Defined as Census Tracts 215.01, 215.02, 215.03, 216.01 and 216.02.

[2] Defined as Census Tracts 217.01 and 217.02.

[3] PTA vacancies based on survey by Colliers Hawaii Consulting in November 2010, with sample representing approximately 84% of the PTA's GLA.

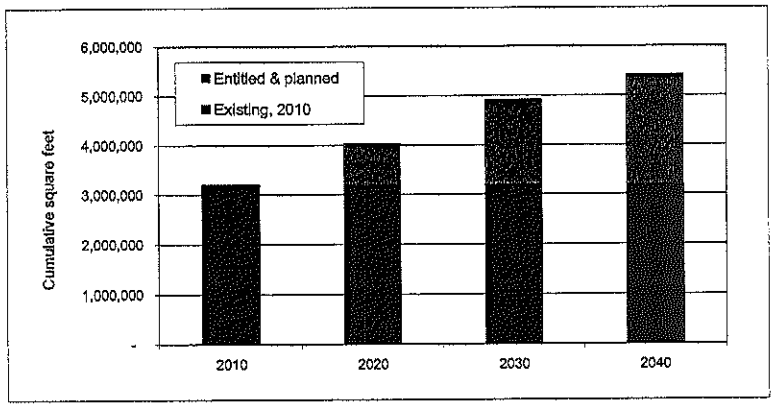
[4] May include ground floor retail.

Sources: Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc., custom and proprietary reports, 2010. Pacific Business News, "Book of Lists 2010," 2010.

Exhibit 5-3
Potential Future Commercial Space - Primary Trade Area
Existing and Planned/Entitled Developments

Square feet of gross leasable area, plans known as of December 2010

	Reference	Existing, Dec. 2010	Potential new market entries 2020	2030	2040	Total
Existing inventory:						
Retail	*Exhibit 5-1*	2,613,000				2,613,000
Office	*Exhibit 5-2*	592,000				592,000
Entitled potential spaces (since prior date):	*Appendix 4, distributed*					
North Kona[1]			680,000	690,000	440,000	1,810,000
South Kohala[2]			150,000	200,000	50,000	400,000
Total			830,000	890,000	490,000	2,210,000
Potential future inventory (cumulative):						
North Kona[1]		2,466,000	3,146,000	3,836,000	4,276,000	
South Kohala[2]		739,000	889,000	1,089,000	1,139,000	
Total		3,205,000	4,035,000	4,925,000	5,415,000	



Note: Includes proposed retail and office uses, but excludes industrial lands that could potentially accommodate similar uses.

[1] Defined as Census Tracts 215.01, 215.02, 215.03, 216.01 and 216.02.

[2] Defined as Census Tracts 217.01 and 217.02.

Exhibit 5-4
Resident Profiles - Primary Trade Area and Benchmarks
2000 Census and 2010 estimates

	Primary Trade Area		
	North Kona[1]	South Kohala[2]	Total PTA
Resident population:			
2000 U.S. Census	28,543	13,131	41,674
2010 estimated	37,300	18,000	55,300
Compound annual % increase, 2000-2010	2.7%	3.2%	2.9%
Median age (2010)	39	36	38
Civilian labor force (2010):			
Number	21,900	10,500	32,400
Percent of population	59%	58%	59%

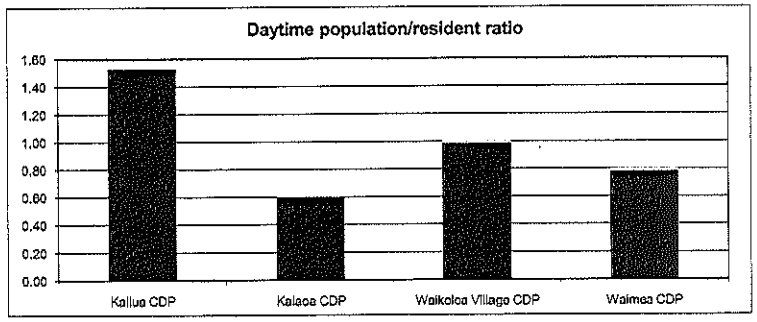
[1] Defined as Census Tracts 215.01, 215.02, 215.03, 216.01 and 216.02.

[2] Defined as Census Tracts 217.01 and 217.02.

Source: Claritas Inc., October 2010.

Exhibit 5-5
Daytime Resident Population and Employment Residence Ratios for Census Designated Places within the Primary Trade Area
2000

	Residents, 2000	Total working in the CDP	Daytime population[1]	CDP daytime population /residents
CDPs in North Kona District:				
Kailua CDP	9,870	9,992	15,036	1.52
Kalaoa CDP	6,794	965	4,036	0.59
Subtotal of CDPs	16,664	10,957	19,072	1.14
CDPs in South Kohala District:				
Waikoloa Village CDP	4,806	2,430	4,713	0.98
Waimea CDP	7,028	1,774	5,466	0.78
Subtotal of CDPs	11,834	4,204	10,179	0.86
Four CDPs combined[2]	56,996	30,322	58,502	1.03



INA = information not available.

Note: All ratios shown are within the respective CDP. Ratios would be higher if reported on a regional basis.

[1] Residents of area plus workers working in area less workers living in area.

[2] Composite of four CDPs covers a smaller and slightly different area than the PTA.

Source: US Census Bureau, Census 2000, PHC-T-40, "Estimated Daytime Population and Employment-Residence Ratios: 2000" Journey to Work and Migration Statistics Branch, 2005.

Exhibit 5-6
Existing Commercial Areas in Relation to User Populations
As of 2010

	Primary Trade Area		
	North Kona[1]	South Kohala[2]	Total PTA
Retail market:			
Estimated consumers:			
Resident population	37,300	18,000	55,300
Daytime population -			
Daytime resident ratio in district[3]	*1.37*	*1.03*	*1.26*
Daytime resident pop. in district	51,200	18,600	69,800
Average daily visitors[4]	10,400	8,200	18,600
Total daytime pop.	61,600	26,800	88,400
Retail GLA[5]	1,937,000	676,000	2,613,000
GLA per daytime population	31	25	30
Office market:			
Estimated users:			
Resident population	37,300	18,000	55,300
Civilian labor force	21,900	10,500	32,400
% in civilian LF	59%	58%	59%
Office RBA[6]	529,000	63,000	592,000
Per civilian employee	24	6	18

[1] Defined as Census Tracts 215.01, 215.02, 215.03, 216.01 and 216.02.

[2] Defined as Census Tracts 217.01 and 217.02.

[3] 2000 CDP ratios, as shown in Exhibit 5-5, are increased 20% to reflect the larger population and employment areas encompassed by the relevant districts. PTA ratios shown here vary from those shown for the CDPs within the PTA in Exhibit 5-5, since the former reflect the total PTA, while the latter is a weighted average for the CDPs, smaller places within each district. No adjustments assumed for economic changes occurring between 2000 and 2010.

[4] Based on estimated 18,622 average daily visitor census in Kona for 2009; distribution within the PTA based on DBEDT's 2008 visitor unit count, with 5,369 in Kona and 4,207 in Kohala/Waimea.

[5] As shown in Exhibit 5-1.

[6] As shown in Exhibit 5-2.

Sources: Claritas Inc., October 2010; Colliers Monroe Friedlander Consulting, November 2010; State of Hawaii, Department of Business Economic Development and Tourism, Hawaii Tourism Authority; Ibid, 2009, "Visitor Plant Inventory".

Exhibit 5-7
Projected Supportable Commercial Areas - Primary Trade Area
In square feet, 2010 to 2040

	Basis/reference	2010	2020	2030	2040	Ave. annual change, 2010-2040
Resident population in Primary Trade Area:						
Population in North Kona-North & South Kohala-Waikoloa[1]	Exhibit 2-4	22,300	39,600	58,800	68,900	3.8%
Trade Area in relation to CRMA (above)	2.7 in 2000 2.5 in 2010	2.5	2.3	2.1	2.1	-0.6%
Population in Trade Area		55,300	91,000	123,000	145,000	3.3%
Retail-based demand assessment:						
Trade Area daytime resident population - *Ratio to resident pop*	*PTA estimated at 1.26 in 2010*[2] *(Ex. 5-6)*	*1.26*	*1.30*	*1.35*	*1.35*	0.2%
Daytime residents		69,800	118,300	166,100	195,800	3.5%
Visitor population[3]	*18,600 in 2010*	18,600	21,800	25,600	30,000	1.8%
Retail consumer population in Trade Area		88,400	140,100	191,700	225,800	3.2%
Supportable GLA in Primary Trade Area	30 sf/daytime population in 2010[4]	28	28	27	27	-0.1%
Area in square feet		2,500,000	3,900,000	5,200,000	6,100,000	3.0%
Office-based demand assessment:						
Civilian labor force Percent of population	59% of resident population in 2010[5]	59%	58%	56%	55%	-0.2%
Number of persons		32,600	52,800	68,900	79,800	3.0%
Supportable RBA in Primary Trade Area	18 sf/person in 2010[4]	16	17	18	20	0.7%
Area in square feet		500,000	900,000	1,200,000	1,600,000	4.0%
Total supportable commercial areas		**3,000,000**	**4,800,000**	**6,400,000**	**7,700,000**	**3.9%**

Note: Demand projections could be conservative in that market support from area second home is residents not explicitly considered.

[1] Census Tracts 215.01 and 217.01, respectively.

[2] Based on estimated ratios derived for the PTA, as shown in Exhibit 5-6.

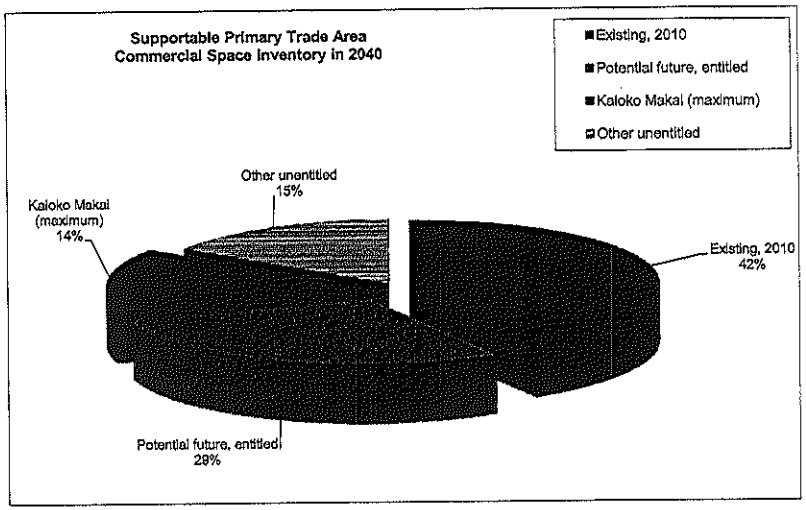
[3] Assumes annually compounded 1.8% average growth in visitor population, most originating in planned interval ownership developments. Projected growth rate based on Department of Business, Economic Development and Tourism, "Population and Economic Projections for the State of Hawaii to 2035; DBEDT 2035 series," January 2008. Table A-68 shows an average 1.1% increase in visitor days from 2010 to 2035 based on the "average growth scenario-baseline scenario." However, those projections do not consider the growing timeshare population of the region. Note also that estimated average daily visitor population in the PTA in 2006 was 21,700 persons, based on DBEDT data, and was unusually depressed in 2010.

[4] As shown in Exhibit 5-6. Supportable ratio for 2010 stated as below inventory level due to high vacancies in 2010; declining retail ratio reflects potential new retailing modes, while rising office ratio reflects an outlook for more professional opportunities within the PTA in the future.

[5] Compares to 48% for island as a whole in 2010, reflecting currently depressed labor market conditions, particularly outside of the PTA (see Exhibit 5-4.) A declining ratio within the PTA in the long-term is anticipated due to aging population.

Exhibit 5-8
Commercial Market Assessment for Kaloko Makai
Cumulative square feet

	Basis/reference	2020	2030	2040
Kaloko Makai commercial market:				
Potential development phasing	*1,100,000 maximum*	500,000	900,000	1,100,000
Share of total future Trade Area		10%	14%	14%
Share of net unplanned PTA market support		65%	61%	48%
Projected supportable in Primary Trade Area:	*Cumulative figures*			
Existing, 2010	*Exhibit 5-3*	3,205,000	3,205,000	3,205,000
Potential future, entitled	*Exhibit 5-3*	830,000	1,720,000	2,210,000
Net additional supportable		765,000	1,475,000	2,285,000
Total	*Exhibit 5-7*	4,800,000	6,400,000	7,700,000



Note: Demand projections could be conservative in that market support from area second home residents is not explicitly considered.

Exhibit 6-1
Existing Business Park/Industrial Supply and Market Indicators - Primary Trade Area
As of December 2010

	North Kona DPA	South Kohala DPA	Total	Comment
Land inventory:				
In net acres -				
Kona Industrial Subdivision	67		67	Mature subdivision adjacent to Kailua-Kona Town.
Kaloko Industrial Park, Phases I & II	110		110	Adjacent to Subject; includes Home Depot, Costco, CS Wo.
Kohanaiki Industrial Park & Honokohau areas	140		140	Adjacent to Subject. Includes McClean Warehouses, Kamanu Street & Huliko'a Drive.
Waimea		5	5	Seiselstad; includes Waimea Self-Storage.
Kawaihae		67	67	Includes DHHL's Kaei Hana II ("I" is in Hilo) & Kawaihae Village, also Kawaihae Industrial Center.
Total net acres	320	70	390	Rounded.
Total in gross acres[1] -	400	90	490	
Undeveloped lands as % of total	15%	1%	12%	"Undeveloped lands" may be encumbered with ground leases and in use.
Built space (square feet):	2,901,000	226,000	3,127,000	Based on CMF survey of approximately 70% of buildings in North Kona and 40% in South Kohala.
Average building vacancy	15%	2%	14%	Up from about 8% in 2008.
Average rent PSF	$0.95	INA	INA	Down 11% since 2008.

Notes: INA - Information not available. Net of government-owned and operated facilities such as military bases, harbors, airports and universities. (Excludes Honokohau and Kawaihae Harbors, Keahole-Kona International Airport, and the Natural Energy Laboratory of Hawaii.)

1 Estimated based on 1.25 times net acres.

Sources: Mikiko Corporation; Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc. 2010, custom report.

Exhibit 6-3
Projected Supportable Business Park/Industrial Land Areas
Cumulative gross acres, North Kona & South Kohala

	Basis/notes	Benchmark - 2010	Projected 2020	Projected 2030	Projected 2040	Average annual change, 2010-2040
Sources of demand:						
Civilian employed persons	Exhibit 5-7	32,600	52,800	66,900	79,800	3.0%
2010 PTA market characteristics:	Exhibit 6-1					
Land area (gross acres)	Year-end	490				
Occupied lands[1]	90% of land area	440				
Future land demand (gross acres, cumulative):						
Required lands for market balance, rounded	10% availability/ surplus	484	780	1,020	1,180	3.0%
Ratio[2]	Employees per gross acre	67	67	67	67	0.0%
Supportable industrial land areas (gross acres, cumulative):						
Less existing areas, 2010	Exhibit 6-1	490	490	490	490	0.0%
Potential delivery of entitled lands	Appendix 5		240	480	620	
Net unentitled demand (surplus), rounded		(10)	50	50	70	

Notes: Net of government-owned and operated facilities such as military bases, harbors, airports and universities. FAR - Floor area ratio.

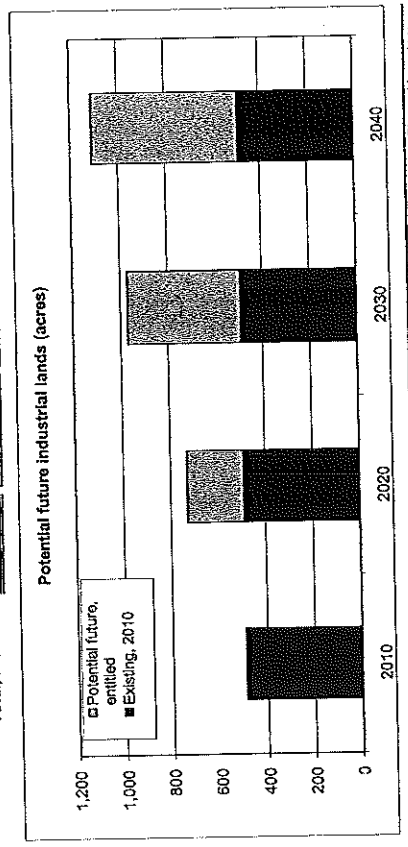
1 Estimated based on the 12% of lands observed to be "undeveloped" (Exhibit 6-1), less a share known to be encumbered by ground leases and that may also be in use, such as for surface parking.

2 Note many of these PTA industrial lands serve island-wide needs but are being benchmarked here to PTA employment levels. Therefore the ratios shown above may appear to be lower than their actual function.

Sources: Mikiko Corporation, 2011; Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc. 2010, custom report.

Exhibit 6-2
Potential Future Business Park/Industrial Lands in North Kona and South Kohala Districts
Existing and Planned/Entitled Developments
Gross acres; plans known as of December 2010

Location	Existing, Dec. 2010 (Ex. 6-1)	Potential new market entries[1] 2020	2030	2040	Total
Entitled potential development (since prior date):					
North Kona	400	230	242	142	614
South Kohala	90	10	0	0	10
Total, rounded	490	240	240	140	620
Potential future supply (existing and planned, cumulative):					
North Kona	400	630	872	1,014	
South Kohala	90	100	100	100	
Total, rounded	490	730	970	1,110	



Note: Gross acres represent salable or leasable areas plus allowance for major roads and other infrastructure. Planned inventory excludes government-owned and operated facilities such as harbors, airports and university campuses.

1 See Appendix 5 for listings. Based on plans known as of December 2010. Some proposed projects assumed to occur beyond the projection period, if at all.

Sources: Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc. 2010, custom report; Interviews with landowners; company web sites.

Exhibit 7-1
Hawaii Island Visitor Unit Inventory
2010

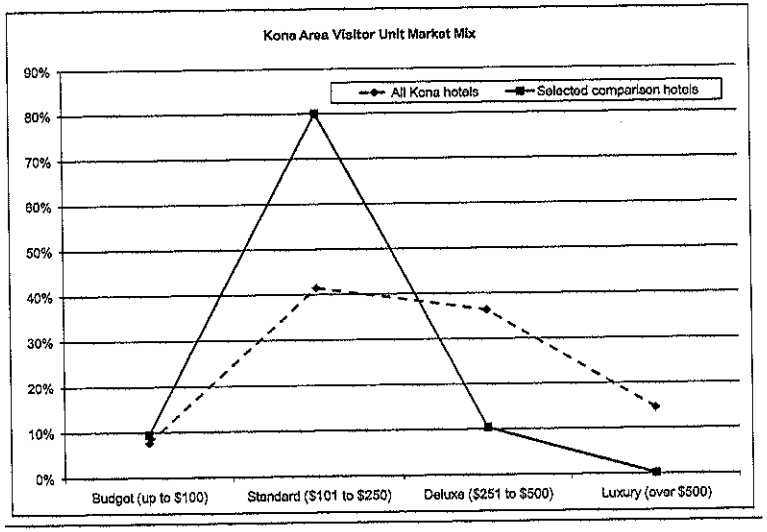
	Number of units	Percent mix
Type of accomodations:		
Hotel	6,958	60%
Individual Vaction Unit[1]	1,675	14%
Timeshare	1,609	14%
Condominium	872	8%
B&B	362	3%
Other	119	1%
Total	11,595	100%
Market orientation (rack room rate):		
Budget (up to $100)		13%
Standard ($101 to $250)		33%
Deluxe ($251 to $500)		40%
Luxury (over $500)		14%
Total		100%

[1] According to the HTA, an individual vacation unit (IVU) may be a condominium unit (not in a hotel rental operation), a house, villa, or cottage or a cabin unit. Unclassified units may also be listed as individual vacation units.
See HTA survey and definitions at:
http://www.hawaiitourismauthority.org/default/assets/File/reports/accommodations/2010-VISITOR-PLANT-INVENTORY-REPORT-FINAL-1.pdf

Source: Hawaii Tourism Authority, 2010 Visitor Plant Inventory.

Exhibit 7-2
Kona Area Visitor Units by Market Orientation
2010

	Year built	Budget (up to $100)	Standard ($101 to $250)	Deluxe ($251 to $500)	Luxury (over $500)	Total
All Kona hotels[1]:						
Number of units		193	1,044	916	366	2,519
Market mix		8%	41%	36%	15%	100%
Selected comparison hotels:						
King Kamehameha's Kona Beach Hotel	1975	0	460	0	0	460
Kona Seaside Hotel	1960	116	109	0	0	225
Royal Kona Resort	1967	0	306	128	2	436
Uncle Billy's Kona Bay Hotel	1975	0	110	0	0	110
Total, selected hotels		116	985	128	2	1,231
Market mix of selected hotels		9%	80%	10%	0%	100%
% of Kona hotel rooms		60%	94%	14%	1%	49%



[1] Includes 125-unit Kona Village Resort (Deluxe to Luxury class), which was closed after being damaged by the tsunami following the Sendai Earthquake on March 11, 2011.

Source: Hawaii Tourism Authority, 2010 Visitor Plant Inventory.

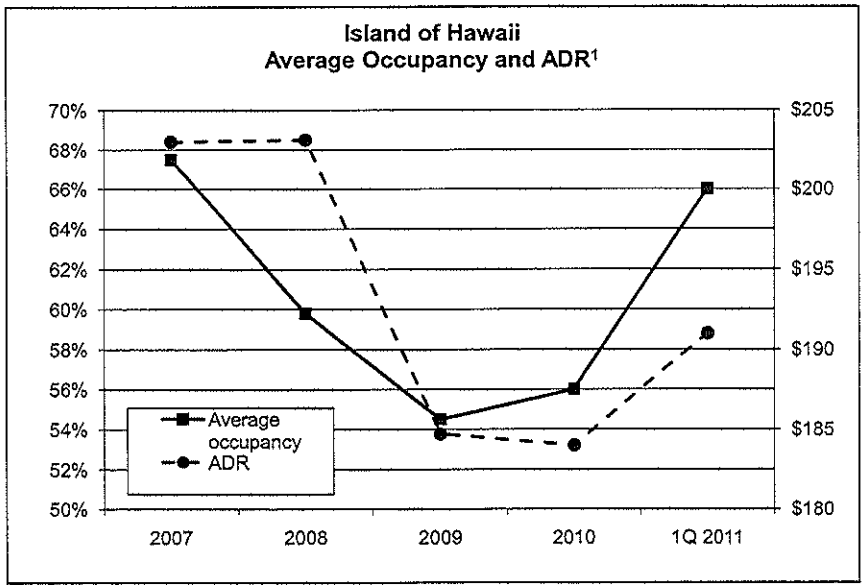
Exhibit 7-3
Kona Out-of-State Visitor Characteristics
2009

	Domestic	International	Total
Visitor days	5,995,257	801,679	6,796,936
Market mix	88%	12%	100%
Average party size	2.0	2.4	2.1
Travel method:			
Group tour	5%	15%	7%
Package	23%	40%	27%
Group tour & package	3%	13%	6%
True independent	69%	32%	61%
Total sample	100%	100%	100%
Length of stay (days):			
In Kona	7.3	4.2	6.7
In State	11.3	9.3	11.0
Accommodations:			
Hotel	45%	68%	49%
Condominium	17%	14%	17%
Timeshare	12%	5%	11%
Friends or relatives	10%	5%	9%
Other (rental house, B&B, cruise ship)	17%	8%	15%
Total sample	100%	100%	100%
Purpose of trip:			
Pleasure (net)	79%	86%	80%
MC&I	7%	4%	6%
Other business	3%	1%	3%
Visit friends or relatives	9%	6%	8%
Sport events	1%	2%	2%
Other (government, military, school)	1%	1%	1%
Total sample	100%	100%	100%

Note: data tracks out-of-State arrivals by air only.
Source: Hawaii Tourism Authority; "Annual Research Tables - 2009, Table 54: Kona Visitor Characteristics: 2009 vs. 2008".

Exhibit 7-4
Hotel Market Performance
2007 - 1Q 2011

	2007	2008	2009	2010	1Q 2011
State of Hawaii:					
Average occupancy	75%	70%	65%	71%	77%
ADR[1]	$200	$201	$177	$174	$191
Island of Hawaii:					
Average occupancy	68%	60%	55%	56%	66%
ADR[1]	$203	$203	$185	$184	$191

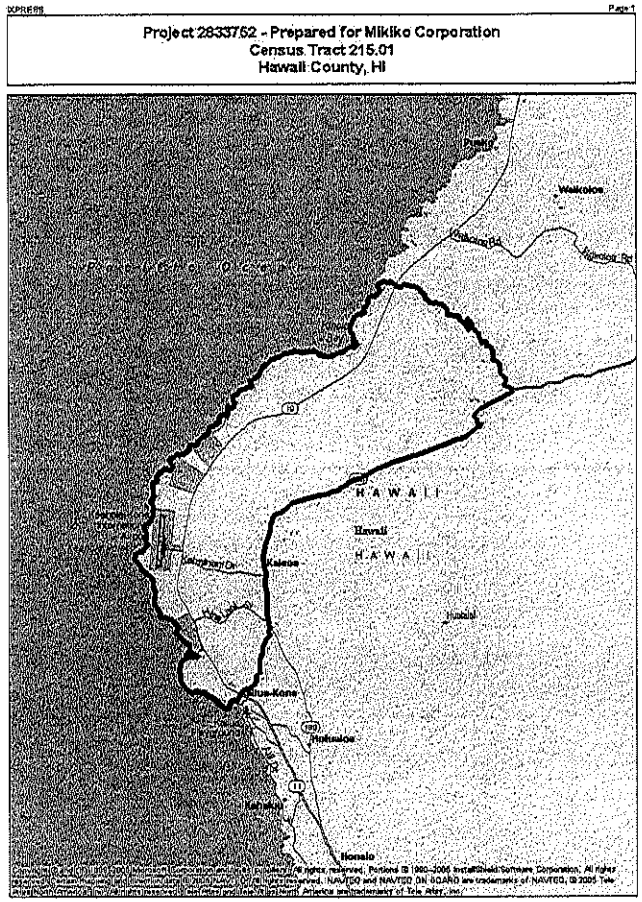


1 Average daily room rate.
Source: Hawaii Tourism Authority, 2009, 2010 and 2011.

Market Assessment for Kaloko Makai

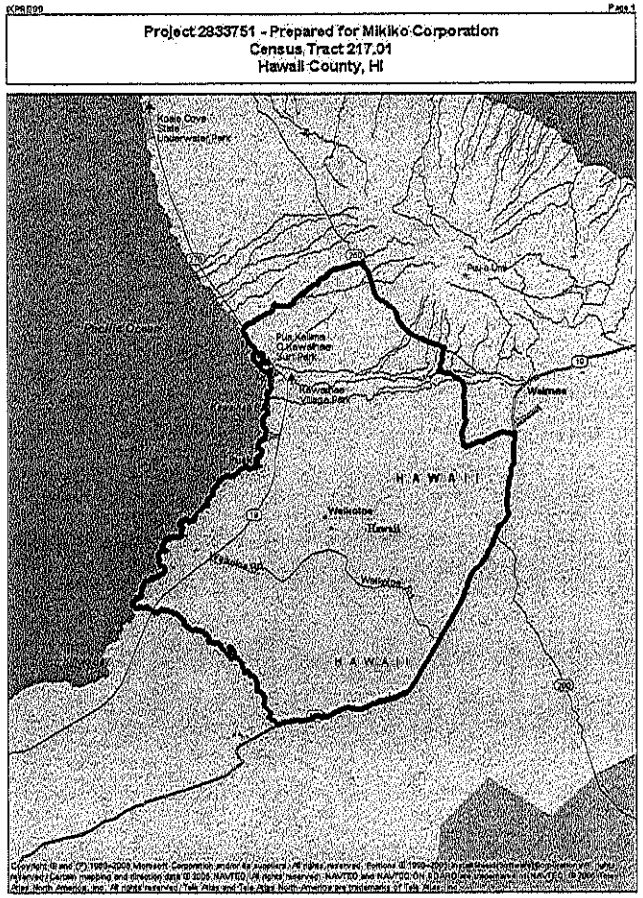
Appendices

Appendix 1: Census Tract 215.01 – Portion of North Kona District Considered Within the Competitive Residential Market Area



Source: Claritas, Inc., 2007.

Appendix 2: Census Tract 217.01 – Portion of South Kohala District Considered Within the Competitive Residential Market Area



Source: Claritas, Inc., 2007.

Appendix 3: Planned Primary Residential Development Projects in CRMA - Census Tracts 215.01 and 217.01, Island of Hawaii

Subject and Primary Residential Projects with
State Entitlement or Exemption, as of December 2010

Project Identification	Landowner or developer	Number of units: Total	Number of units: Built by 12/ 2010	Number of units: Potential for 2011+	*Est % primary resident & buildout*[1]	Projected additional RHU at buildout	Comment
North Kona-North (CT 215.01):							
Subject: Kaloko Makai	*SCD-TSA Kaloko Makai, LLC*	*5,000*	*0*	*5,000*	*85%*	*4,250*	
Palamanui (previously Hilu Hilu)	Palamanui LLC (Hunt Development Group/Charles Schwab/Guy Lam)	1,116	0	1,116	80%	890	Total is max per 2/2010 ordinance. Excludes dormitories. TND design within 725-acre site tied to proposed UH West Hawaii Center.
Kula Nei	The Shopoff Group, LP (TSG Kula Nei LP & Springbrook Investments, LP)	270	0	270	60%	160	216-220 lots plus affordable housing. 3/4-mi makai of Mamalahoa, adjacent and to north of Kaloko Heights.
Keahole Heights Phase II	INA - marketed by American Dream Realty	40	29	11	60%	10	On Oneone St., northern side of Kaiminani
Kaloko Heights	Stanford Carr Development/Kaloko Heights Associates LLC	1,362	0	1,362	75%	1,020	Adjacent to Subject, on Hina Lani. Urban designation for southern half of site vests after meeting completion goals on northern half per LUC, 1988.
Villages of La'i 'Opua (Koalakohe ahupua'a)	State - DHHL	1,097	225	872	95%	830	SF at Villages 1,2,4,5,7. V5 now being developed/marketed. V3 is completed. Others are planned for nonresidential uses or are indefinite.
Keahuolu	State - DHHL	750	0	750	95%	710	150 acres adjacent to La'i 'Opua; potential development not likely until 2020+ (after Lai Opua.)
Kamakana Villages	State-HHFDC landowner; Forest City developer.	2,330	0	2,330	95%	2,210	272 acres mauka of Ane Keohokalole Hwy. LUC approved plan 11/4/2010.
Seascape Phase I	Formerly Seascape Development LLC	108	92	16	95%	20	Stalled. For-sale condominiums. 25 or 26 sold. Lender took over but has gone insolvent.
Seascape Phase II	Formerly Seascape Development LLC	300	0	300	95%	290	Stalled. 10-acre extension to Seascape site, south of end of Kakahiaka St. Affordable housing.
Lohaki Makai	Sonny Ventures, LLC	191	97	94	70%	70	Stalled. Vacant lots. Developer related to Seascape. Phases I & II sold 4-5 years ago; III - V on hold.
Waihoni Estates	INA; marketed by Clark Realty Corporation	49	29	20	70%	10	Lots, 15,000 to 25,000 sf and some finished homes. Ko'iko'i and Kaiminani Streets.
Kaloko Housing Project	County of Hawaii, OHCD	72	0	72	100%	70	Broke ground June 2010. 96 units total. On Hina Lani St., south and adjacent to Subject. Figure is net of 24 u lost at Hale O Kawaihae Transitional Housing Program.

Appendix 3: Planned Primary Residential Development Projects in CRMA - Census Tracts 215.01 and 217.01, Island of Hawaii

Subject and Primary Residential Projects with
State Entitlement or Exemption, as of December 2010

Project Identification	Landowner or developer	Number of units: Total	Number of units: Built by 12/2010	Number of units: Potential for 2011+	Est % primary resident & buildout[1]	Projected additional RHU at buildout	Comment
South Kohala-Waikoloa (CT 217.01):							
Wehilani (formerly "Na Puu Nani")	Castle & Cooke Waikoloa LLC (C&C Homes Hawaii, Inc. subsidiary)	804	104	700	70%	490	Makana Kai (68 MFs) and Kikana (36 SFs) closed out 2009. Rest on hold. West & south of Waikoloa Village entrance.
Kilohana Kai at Waikoloa Phase II	Marketed by Hawaiian Island Homes	230	116	114	65%	70	80 homes/150 vacant lots. Ph I (51) sold 2005; Ph II (148) on market with 83 shown available; Ph III (31) on hold.
Kamakoa Nui (Waikoloa Workforce Housing)	County of Hawaii	1,200	0	1,200	95%	1,140	Infrastructure complete; first phase of 91 units projected for 1Q2012 with County as developer, Coastal building model homes.
Sunset Ridge	Towne Development	197	136	61	25%	20	Phases 5 & 6 now on market; developer asked County to rescind Phase 7. Mostly second home buyers.
Keolalani at Waikoloa (formerly "Waikoloa Heights")	Keolalani Investment Partners (purchased from Lynch; entity known as Waikoloa Ma La'i)	2,000	0	2,000	20%	400	On hold. Zoned for up to 3,000 units but unlikely; RHU % considers slope, lack of affordable condition and stated intention to price above Sunset Ridge.
Kohala Place at Waikoloa ("Waikoloa Village")	Metric Passco Waikoloa, LLC (may have lost project)	300	0	300	65%	200	Project in default. 45 acres total: 300 apartments, commercial & business park. Across Waikoloa Road from Village Golf Course.
Totals, rounded (excluding Subject):							
	North Kona-North	7,700	500	7,200		6,300	
	South Kohala-Waikoloa	4,700	400	4,400		2,300	
		12,400	900	11,600		8,600	

Note - Based on survey of projects planned on lands with State Land Use "Urban" designation as of November 2010, or with landowner that may be exempt from LUC governance. Survey targeted projects of 100 or more planned units. Excludes projects developed in conjunction with beachfront resorts offering golf and/or hotel amenities; also excludes QLT Urban lands for which LUC petitions to be filed to redesignate uses from commercial to residential. Figures shown based on stated owner or developer plans where available, else maximum entitled units.

DEIS - Draft Environmental Impact Statement; DHHL - Department of Hawaiian Home Lands; DLNR - Department of Land & Natural Resources; HHFDC - Hawaii Housing Finance & Development Corporation; INA - Information not available; LUC - State Land Use Commission; MF - Multifamily; MFY - median family income; MU - Mixed use development including residential and retail uses; QLT - Queen Lili'uokalani Trust; RHU - primary resident housing unit sf - square feet; SF - Single-family detached home; TH - Townhouse (multifamily); u - residential unit.

[1] Reflects estimated percent of project anticipated to sell to primary residents already established on-island and the likelihood of project building to maximum entitled capacity.

Sources: Interviews with project principals, developers, planners and brokers, and County and State officials; Honolulu Star Advertiser; Pacific Business News; West Hawaii Today; State of Hawaii, Office of Environmental Quality Control; project websites and Internet searches.

Appendix 4: Entitled and Planned Commercial Developments in the North Kona and South Kohala Districts, Island of Hawaii

Lands with State Entitlement or Exemption, as of December 2010

Project Identification	Location	Landowner or developer	Site area (Ac)	Estimated GLA (Sq. ft.)	Comments
North Kona:					
Subject: Kaloko Makai	*Hina Lani Street and Queen Kaahumanu*	*SCD-TSA Kaloko Makai, LLC*	*INA*	*1,100,000*	
Kaloko Heights	Mauka of Subject	Stanford Carr Development/Kaloko Heights Associates LLC	6	60,000	Neighborhood commercial; zoned CN-20. Parcel currently on market for sale or land lease.
Kamakana Village	North of Pelani Road, between QLT lands	Forest City/State of Hawaii, HHFDC	18	100,000	Received LUC-U approvals Fall 2010. Part of 272-acre affordable master-planned community awarded to Forest City for development.
Palamanui (previously Hilu Hilu)	North of Airport	Hunt Development Group/Charles Schwab/Guy Lam	INA	100,000	UH West Hawaii Center to open in 2012. Village and Community Commercial areas designated within 725-acre site. Excludes 70-acre potential business park shown on industrial analysis.
Kona Commons	N. of Kona Industrial Park	QLT lands; Kona Commons LLC (MacNaughton Group & Kobayashi Group)	INA	305,000	GLA shown is net additional (Phase I of 132,000 SF completed in 2008, 160,000 SF Target opened 2009.)
Kalaoa area (south of Palamanui)	1 across Airport, 1 South of Kaiminani	State Department of Hawaiian Home Lands	40	400,000	Assumed retail portion of two parcels being marketed Jan 2011 (152 acres gross, 122 acres net); balance allocated to industrial. Lease offerings in 2009 & 2010 yielded no results.
DHHL La'i'Opua Other	Within Villages of La'i'Opua	State Department of Hawaiian Home Lands	INA	245,000	Maximum potential developments on Villages 7 & 8 of 350K adjusted because portions of V7 may be undevelopable; no current plans for either.
CG10 site	Keahuolu - South of Pelani, Makai of Henry Street	Queen Lili'uokalani Trust Estate	10	110,000	Project on hold. Office and retail potential development; no residential planned at this time.
Lots 14 & 15	Keahuolu - Kona Industrial Subdivision	Queen Lili'uokalani Trust Estate	9	60,000	To resubmit to LUC due to old approvals; Project on hold; plans under review.
Makalapua Shopping Center Phase 2	Keahuolu - adjacent existing	Queen Lili'uokalani Trust Estate	20	110,000	To resubmit to LUC due to old approvals. Currently on hold due to poor market conditions. Up to 20-acre expansion permitted by water agreements within current Urban Phase 1.
Lanihau Shopping Center Phase 2	Kailua-Kona outskirts	Westwood Development Group	22	220,000	Fronts Henry Street. Westwood recently sold Lanihau Center back to A&B, but still holds these vacant lands.
South Kohala:					
Kohala Place at Waikoloa (prev. "Waikoloa Village")	Waikoloa Rd. and Puu Mela St.	Metric Passco Waikoloa, LLC	13	200,000	Development postponed. Zoned CV-10; project also includes residential rentals, senior housing, business park lands, hotel.
Waimea Town Center	Waimea Town, various locations	Parker Ranch	90	200,000	Town Center Plan under review; represents maximum development expected.
Totals of available information, rounded (excluding Subject):					
	North Kona			1,810,000	
	South Kohala			400,000	
	Total, Primary Trade Area			2,210,000	
				2,210,000	

Note: Survey covers projects with LUC "Urban" designation as of December 2010. Survey targeted community and regional facilities, generally those of 20,000 square feet or more.

INA - Information not available; Ac - Acres; LUC - Land Use Commission; U/C - Under construction; MUD - mixed-use development, including residential and retail; SC - Shopping center

Sources: Interviews with project developers, landowners, planners and brokers; area site visits; Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc., December 2010; Pacific Business News (weekly); developer websites; Honolulu Star Advertiser; West Hawaii Today.

Appendix 5: Entitled and Planned Industrial Developments in the North Kona and South Kohala Districts
As of December 2010

	Location	Landowner or developer	Site area (gross acres)	Comments
North Kona:				
Subject: Kaloko Makai	***Hina Lani Street and Queen Kaahumanu***	***SCD-TSA Kaloko Makai, LLC***	***75***	***25 acres interim use and 50 acres long-term use.***
Kaloko Industrial Park Phases III and IV	Hina Lani Street	TSA Corporation	105	Phase III (Kaloko Business Center) 41 net acres, infrastructure completed in 2009; future Phase IV estimated at 57 net acres.
West Hawai'i Business Park	Queen Kaahumanu Hwy	Lanihau Partners	327	337 gross acres less 10 net acres used by West Hawaii Concrete as quarry, with one building. To be marketed as lots.
Palamanui	Queen Kaahumanu Hwy	Palamanui Global Holdings LLC	70	Planned as condominium lots in business park; Phase I is 29 acres.
Kalaoa	Across from Airport, south of Palamanui	DHHL	112	Portion of 152 acres offered at 2 sites on Queen Kaahumanu Hwy.; balance assumed to be retail/office.
South Kohala				
Waikoloa Village	Waikoloa Village, Pua Melia Rd.	Formerly Passco Waikoloa LLC & Metric Waikoloa, LLC	10	Total site of 45 acres previously planned for 200,000 SF retail, 300 apts, limited service hotel as well as business/industrial park.

Area summaries, excluding Subject

North Kona	614
South Kohala	10
Total, rounded	620

Notes: Excludes potential government-sponsored or related enterprises at Airport, Honokohau Harbor, and at NELHA. Also excludes lands between Kalaoa and Palamanui which DHHL recently acquired from State for "income purposes," but for which no plans have yet been determined.

Sources: Mikiko Corporation, 2011; Colliers Hawaii Consulting, A Division of Colliers Monroe Friedlander, Inc, 2010, custom report; Pacific Business News; interviews with landowners.

Appendix 6: Report Conditions

This assessment is based on information provided by government agencies, developers, brokers, landowners, and other third party sources. While every attempt has been made to verify information via multiple sources, it is not always possible to do so. Mikiko cannot guarantee the accuracy of all information upon which its assessments may be based.

Mikiko has no responsibility to update this report or any of the underlying data for events and circumstances occurring after December 31, 2010, the date of substantial completion of primary data collection.

This report is for the planning purposes of SCD-TSA Kaloko Makai, LLC and its consultants, as well as for public disclosure of the nature of Kaloko Makai pursuant to seeking State and County land entitlements. It is not to be used for solicitation of investment or other third party purposes without prior written consent of the author.

This report does not offer an appraisal of Kaloko Makai, nor should it be construed as any opinion of value for Kaloko Makai.

Appendix B

Service Area Health Care Facilities Forecast – Kaloko Makai
Cattaneo & Stroud, Inc.
June 2011

Cattaneo & Stroud, Inc.

Consultants to the Health Care Industry

1601 Old Bayshore Highway, Suite 107
Burlingame, California 94010

Service Area Health Care Facilities Forecast - Kaloko Makai

Prepared for:
SCD-TSA Kaloko Makai, LLC

Prepared by:
Cattaneo & Stroud, Inc.

June 2011

Summary of Kaloko Makai Health Care Facilities Forecast

SCD-TSA Kaloko Makai, LLC is reserving 40 acres of land for the potential development of a hospital. SCD-TSA is not committed to developing the new hospital or any of the suggested support facilities indicated in this study. The purpose of this study is to show potential staffing requirements and space (square footage) demands for a finite number of healthcare facilities based on current and future population figures as well as Medical visit records produced by the Hawaii Health Information Corporation.

A population-based forecast of the health care facility and manpower needs for the residents of the Kona Coast region resulted in the following plan for health care facilities development:

Service Area Health Care Facilities Forecast - Kaloko Makai	
Campus Planning Scenarios: Phase One (2015-2020)	
Medical Office Building (# MDs)	10
Urgent Care	4,500
Hospital	
Skilled Nursing/LTC	50
Campus Planning Scenarios: Phase Two (2020-2030)	
Medical Office Building (# MDs)	50
Urgent Care	5,100
Hospital	130
Skilled Nursing/LTC	100
Campus Planning Scenarios: Phase Three (2030-2040)	
Medical Office Building (# MDs)	100
Urgent Care	5,700
Hospital	150
Skilled Nursing/LTC	150

The forecast is presented in three phases that result in the estimated need for the following services:

- **Medical Office Building(s):** The estimated number of physicians that would locate in the proposed Kaloko Makai development. Phase One would occur early in the development and before a hospital is located in the area, hence the offices would start small, with limited ancillary services (xray, lab draw station, pharmacy) to support the community and medical practices. Over the next five to ten years, as the development grows and plans for the hospital are

completed, medical office needs would grow to an estimated 50 physicians. As the community and hospital grow, the need for physician offices will grow to up to 100 physicians.

- **Urgent Care:** The Urgent Care component of the project will meet the immediate medical needs of the growing community, in concert with the physician offices, as well as provide access to health care for lower acuity cases. The forecast is based on an assumption that approximately 17% of emergency visits are low acuity, based on a 2010 study of Hawaii resident cases. When the hospital opens, the urgent care function would be coordinated with the hospital emergency room to determine the optimal staffing and facility for both services.

- **Hospital:** Construction of the hospital is anticipated in Phase Two which is forecast to occur between 2020 – 2025. This plan assumes that the hospital is built in two phases, with the first hospital building sized to house up to 130 beds. However, capacity could be phased in depending on how quickly demand develops in the area. Overall demand for acute care beds is forecast to reach 150 by 2035 at recent use rates for Big Island residents of the Kona Coast. Additionally, a portion of beds could be operated as "swing beds", i.e. they could be operated as acute or skilled nursing based on demand.

- **Long Term Care:** There is a significant shortage of long term care beds in the state of Hawaii, including on the Big Island. The elderly population is the fastest-growing component locally and statewide. This project proposes to develop a fifty bed facility in Phase One with fifty bed increments added in Phases Two and Three, for a total of 150 beds.

Summary

The proposed health care facilities address a growing need for local services to support the needs of the regional population. Over the past few years, local and state groups have documented the shortage of skilled nursing and long term care beds, the shortage of physicians, and the aging status of the state's hospitals. The Kaloko Makai development includes a continuum of modern, needed services that should provide a strong foundation for community health and for attracting health professionals to the region.

Health Care Facilities Forecast - Kaloko Makai

Revised as of June 2011

Campus Planning Scenarios: Phase One

Building Types	Components	Building GSF	Parking	Acreage for new Buildings
Outpatient Care Center	Imaging, Lab, Pharmacy, Urgent Care	14,629	73	1.28
MOB #1	10 MD Office/Suites	18,750	94	1.44
Hospital	No hospital this phase	-	-	-
Skilled Nursing/LTC	No Skilled Nursing Beds	-	-	-
	Totals	33,379	167	2.72

Campus Planning Scenarios: Phase Two

Building Types	Components	Building GSF	Parking	Acreage for new Buildings
Outpatient Care Center	Expand OP service. Add Ambul Surgery	23,639	118	2.06
MOB #2	30 MD Office/Suites	56,250	281	4.33
Hospital	No hospital this phase	-	-	-
Skilled Nursing/LTC	50 Skilled Nursing Beds	32,500	75	1.71
	Totals	112,389	474	8.10

Campus Planning Scenarios: Phase Three

Building Types	Components	Building GSF	Parking	Acreage for new Buildings
Outpatient Care Center	New OP services replaces UC & ASC	23,639	118	2.06
MOB #3	50 MD Office/Suites	93,750	469	6.78
Hospital	100 bed hospital this phase	185,000	500	8.55
Skilled Nursing/LTC	100 Skilled Nursing Beds	60,000	150	3.31
Service Building 1		6,000	12.00	0.34
	Totals	362,389	1,237	21.04

Campus Planning Scenarios: Phase Four

Building Types	Components	Building GSF	Parking	Acreage for new Buildings
Outpatient Care Center	OP Services expands by 25%	29,548	148	2.58
MOB #4	100 MD Office/Suites	187,500	938	13.56
Hospital	150 bed hospital this phase	270,000	750	12.74
Skilled Nursing/LTC	150 Skilled Nursing Beds	82,500	225	4.79
Service Building 2		10,000	20	0.57
	Totals	569,548	2,060	34.23

Campus Staffing Forecast - Kaloko Makai

Revised as of June 2011

Building Types	Staffing Assumptions	Building GSF	MD's	Total Staff
Outpatient Care Center	1 MD plus 4 staff/ 2000 usable SF	14,629	9	47
MOB #1	1 MD plus 4 staff/ 1500 usable SF	18,750	10	50
Hospital	No hospital this phase	-	-	-
Skilled Nursing/LTC	No Skilled Nursing Beds	-	-	-
	Totals	33,379	19	97

Building Types	Staffing Assumptions	Building GSF	MD's	Total Staff
Outpatient Care Center	1 MD plus 4 staff/ 2000 usable SF	23,639	9	47
MOB #2	1 MD plus 4 staff/ 1500 usable SF	56,250	30	150
Hospital	No hospital this phase	-	-	-
Skilled Nursing: 50 Beds	1.6 staff/ bed	32,500		275
	Totals	112,389	39	472

Building Types	Staffing Assumptions	Building GSF	MD's	Total Staff
Outpatient Care Center	1 MD plus 4 staff/ 2000 usable SF	23,639	9	47
MOB #3	1 MD plus 4 staff/ 1500 usable SF	93,750	50	250
Hospital: 100 Beds	5.5 staff/ bed	185,000		550
Skilled Nursing: 100 Beds	1.6 staff/ bed	60,000		160
Service Building 1	Included in hospital staff	6,000		
	Totals	362,389	59	1,007

Building Types	Staffing Assumptions	Building GSF	MD's	Total Staff
Outpatient Care Center	1 MD plus 4 staff/ 2000 usable SF	29,548	12	59
MOB #4	1 MD plus 4 staff/ 1500 usable SF	187,500	100	500
Hospital:150 Beds	5.5 staff/ bed	270,000		825
Skilled Nursing: 150 Beds	1.6 staff/ bed	82,500		240
Service Building 2	Included in hospital staff	10,000		
	Totals	569,548	112	1,624

Kaloko Makai, Medical Campus: Site Planning Scenarios

SCD-TSA Kaloko Makai, LLC

Revised as of June 2011

Building Group by Phase	Building GSF	Parking Spaces	Building Site in Acres	Peak Trips per Hour
Outpatient Care 1	14,629	73	1.28	76
Outpatient Care 2	23,639	118	2.06	122
Outpatient Care 3	23,639	118	2.06	122
Outpatient Care 4	29,548	148	2.58	153
MOB 1,	18,750	94	1.44	70
MOB's 2	56,250	281	4.33	209
MOB's 3	93,750	469	6.78	349
MOB's 4	187,500	938	13.56	698
Skilled Nursing, 50 beds	32,500	75	2.46	14
Skilled Nursing, 100 beds	60,000	150	4.68	25
Skilled Nursing, 150 beds	82,500	225	6.68	35
Hospital: 100 beds	185,000	500	8.55	218
Hospital: 150 beds	270,000	750	12.74	319
Service Building 1	6,000	12	0.34	7
Service Building 2	10,000	20	0.57	12

Traffic Volumes for each building-type based on guidelines from the Institute for Transportation Engineering

Traffic Volumes (Peak Trips per hour) do not occur across all buildings at the same hour.

"Building Acreage" does not include Storm Detention areas or Open Space

Kaloko Makai, Medical Campus, Medical Office Buildings

SCD-TSA Kaloko Makai, LLC Revised as of June 2011

Building by Phase (1)	Total MD's	GSF /MD Suite	Total GSF	Total of MOB's Footprint (2)	Total Footprint Acres
MOB 1	10	1,500	18,750	10,313	0.24
MOB's 2	30	1,500	56,250	30,938	0.71
MOB's 3	50	1,500	93,750	32,813	0.75
MOB's 4	100	1,500	187,500	65,625	1.51
Parking Spaces by Phase (3)			**Parking GSF**	**With all Drives, Landscape & Misc (4)**	**Total Site Work Acres**
MOB 1	94		37,500	52,500	1.44
MOB 2	281		112,500	157,500	4.33
MOB 3	469		187,500	262,500	6.78
MOB 4	938		375,000	525,000	13.56

Notes:

1. Medical Office Building with 80% Usable per floor
2. Building Footprint assumes 2 story building with 55% at grade level
3. Parking at 5 Spaces/ 1000 GSF
4. Roadways, Landscape & Misc Sitework at 40% of Parking lots

Kaloko Makai, Medical Campus: Skilled Nursing Facility

SCD-TSA Kaloko Makai, LLC Revised as of June 2011

Building Group by Phase (1)		GSF/Bed	Total GSF	Building Footprint (2)	Building Footprint Acres
SNF 1: Beds	50	650	32,500	32,500	0.75
SNF 2: Beds	100	600	60,000	60,000	1.38
SNF 3: Beds	150	550	82,500	82,500	1.89
Parking Spaces by Phase (3)		**GSF/Space**	**Parking GSF**	**With all Drives, Landscape & Misc (4)**	**Total Site Work Acres**
SNF 1:	75	400	30,000	42,000	1.71
SNF 2:	150	400	60,000	84,000	3.31
SNF 3:	225	400	90,000	126,000	4.79

Notes:

1. Freestanding SNF w/ 80% Semi-private rooms and minimal outsourcing of medical services
2. Building Footprint assumes 1 story building with 100% at grade level
3. Parking at 1.5 Spaces/ Bed
4. Roadways, Landscape & Misc Sitework at 40% of Parking lots

Kaloko Makai, Medical Campus: Community Hospital

SCD-TSA Kaloko Makai, LLC — Revised as of June 2011

Building Group by Phase (1)		GSF/Bed (5)	Total GSF	Building Footprint (2)	Building Footprint Acres
Hospital 3: Beds 100		1850	185,000	92,500	2.12
Hospital 4: Beds 150		1800	270,000	135,000	3.10
Parking Spaces by Phase (3)		**GSF/Space**	**Parking GSF**	**With all Drives, Landscape & Misc (4)**	**Total Site Work Acres**
Hospital 3: Beds	500	400	200,000	280,000	8.55
Hospital 4: Beds	750	400	300,000	420,000	12.74

Notes:

1. Community Hospital w/ private rooms and minimal outsourcing of medical services
2. Building Footprint assumes 3 story building with 50% at grade level
3. Parking at 5 Spaces/ Bed
4. Roadways, Landscape & Misc Sitework at 40% of Parking lots

Kaloko Makai, Medical Campus, Outpatient Care Center

SCD-TSA Kaloko Makai, LLC — Revised as of June 2011

Building Group by Phase		GSF for these services	Total GSF	Building Footprint	Total Footprint Acres
Outpatient Care Center 1	Imaging, Lab & Urgent Care (1)	11,704	14,629	14,629	0.34
Outpatient Care Center 2	Expand OP, Add ASC (2)	18,911	23,639	23,639	0.54
Outpatient Care Center 3	Backfill OP as UC & ASC move to hosp (3)	18,911	23,639	23,639	0.54
Outpatient Care Center 4	Expand OP services by 25% (4)	23,639	29,548	29,548	0.68
Parking Spaces by Phase (6)		**GSF/Space**	**Parking GSF**	**With all Drives, Landscape & Misc (5)**	**Total Site Work Acres**
OCC 1	73	400	29,259	40,962	1.28
OCC 2	118	400	47,278	66,189	2.06
OCC 3	118	400	47,278	66,189	2.06
OCC 4	148	400	59,097	82,736	2.58
Total all ACC phases	457		182,911	256,075	5.88

Notes:

1. Includes Imaging rooms, Draw Stations, 8 bed Urgent Care Center & Support Space
2. Adds ASC with 2 ORs, Prep/Recovery & Support Spaces
3. ASC and UC to hospital. Backfill spaces with PT and Women's Center
4. All OP centers grow by 25%
5. Roadways, landscaping and misc sitework 40% of parking lots
6. Outpatient Parking Ratio, 5 spaces/1000 GSF

Kaloko Makai Health Campus	*Facility Master Planning*
Space Program	Revised as of June 2011

Urgent Care Center

Room Name or Space Reqd.	Remarks	Units	SF/Unit	Total SF
Waiting Room	Seats 20 plus child's play area	1	400	400
Volunteers Station	Desk and Refreshment Cart	1	40	40
Public Toilet		2	55	110
Reception & Registration	2 Registration Booths & Work counter	1	60	60
Staff Stations				
Central Nurses Station	Workstations for 6 Staff	1	160	160
MD Dictation	2 Workstations	1	30	30
Medication Room	Automated Dispensing	1	60	60
PACS Viewing Station		1	40	40
Medical Supplies	Cart Resupply Room	1	80	80
Clean Utility	Sink Counter and Storage	1	100	100
Linen Storage	Linen Carts	1	20	20
Soiled Utility	Hopper Sink	1	60	60
Treatment Bays				-
Fast Track/ Minor Treatment	Partial Walled Stations w/ Cubicle Curtain	4	100	400
Exam Rooms	Isolated / Secured Exam Room	4	120	480
Handwash Stations	Staff Stations	1	10	10
Patient Toilets		2	55	110
Support Services				
MD Office		1	100	100
Unit Managers Office		1	100	100
Electrical Closet		1	60	60
Communication Closet		1	40	40
Janitor Closet		1	40	40
Staff Lockers/ Showers		1	140	140
Staff Conference Lounge	Table & Kitchenette	1	120	120
Staff Toilet		1	60	60
		Total Net SF		2,820
		Circulatio	1.5	1,410
		Total SF		4,230

Pharmacy

Prescription Preparation	3 Fill Stations, Dispensing and Sink	1	60	60
Cashier Station	Swing staff w/ pharmacy	1	20	20
Pharmaceutical Shelving	350 LF of Shelving	1	100	100
Bulk Stores and workroom		1	60	60
Pharmacy Waiting	5 seats	2	15	30
Retail Shelving	Medical/ Retail. No food or DME	1	200	200
		Net SF		470
		Circulation 1.4		188
		Subtotal SF		**658**

Outpatient Reception/ Waiting Area

Room Name or Space Reqd.	Remarks	Units	SF/Unit	Total SF
Entry/ Waiting				
Entry Vestibule	Separate entry from Women's Center	1	100	100
Reception Desk	2 Workstations, Copier, Fax	1	100	100
				-
Registration				-
Registration Cubicles	Access to Women's & Amb Care Waiting	2	60	120
Clerical Area	Copy, Chart Assembly, Files & Storage	1	100	100
Financial Counseling/ Insur Verif.	PAT discharge counseling	1	100	100
				-
Waiting Area				-
Patient/ Family Waiting	General waiting, seats (120	1	240	240
Children's Area	Quiet play, games, puzzles	1	50	50
Toilets		2	60	120
Health Resource Center	Books, Videos, Operable Wall	1	100	100
		Net SF		1,030
		Circulation 1.5		515
		Subtotal SF		**1,545**

Lab and Testing Services

Room Name or Space Reqd.	Remarks	Units	SF/Unit	Total SF
Point of Care Testing	Countertop equipment. Basic tests	1	100	100
Specimen Processing	Specimen storage, sorting & pick -up	1	40	40
Workstation	Paperwork station	1	65	65
Lab Storage	Lab Supplies & Refrig. Storage	1	40	40
Testing/ Consult Rooms	Draws, EKG, History, Staff Work	1	100	100
Draw Stations	Draw Chair & phlebo. cart	2	70	140
Clerical Work	Chart assembly & Storage	1	80	80
Toilet	Specimen collections	1	55	55
(Group Teach in RMP Conf Room)				-
		Net SF		620
		Circulation 1.4		248
		Subtotal SF		**868**

Imaging Services

Room Name or Space Reqd.	Remarks	Units	SF/Unit	Total SF
Reception/ Scheduling				
Reception/ Scheduling	Workstations, Copier, Fax	1	80	80
Sub-Waiting for Imaging	Seats 4 w/ Main Waiting nearby	1	100	100
Men's Change Booths	Booths w/ adjacent patient lockers	2	30	60
Women's Change Booths	Booths w/ adjacent patient lockers	2	30	60
Women's Toilet		1	55	55
				-
Image Reading & Processing				-
PAC Work Stations/ Film Reading	PAC & Large Film Reading cubicles	1	80	80
Radiologists Work Stations	Work cubicles	1	50	50
Clerical Area	Clerical, Copy, Sorting	1	100	100
Dept Manager	Private Office	1	80	80
Utility Storage	Paper Storage & Coffee/ microwave	1	100	100
				-
Rad/ Flouro				-
Rad/Flouro Room	Digital R/F	2	320	640
Control Areas	Shared Room Controls	1	75	75
R/F Toilet	Toilet w/ 2 doors	1	60	60
Radiographic Rooms	Rad Unit w/ Chest Stand	1	225	225
				-
Central Workroom/ Processing				-
Central Workroom/ Processing	Rad Techs, Film Load, Digital Q/A	1	120	120
Darkroom	Film Process	1	65	65
Tech Lounge	Conf, Lockers, Kitchenette	1	100	100
Staff Toilet		1	55	55
				-
Mammo & UltraSound Suite	Adjacent to Women's changing area			-
Ultrasound Exam Rooms		1	150	150
Mammography	Change at Dressing Area	1	140	140
Work/Utility		1	60	60
				-
Support Functions				-
General Storage Rooms		1	100	100
Hallway Alcoves	Wheelchair, Equip Storage	2	30	60
Staff Locker/ Toilet	lockers, Toilet & Shower	1	120	120
General Staff Lounge and Conf.	Used by all Amb. Care Staff	1	100	100
Janitor Closet		1	40	40
Electrical Room		1	60	60
		Net SF		2,935
		Circulation 1.5		1,468
		Subtotal SF		**4,403**

Ambulatory Surgery

Room Name or Space Reqd.	Remarks	Units	SF/Unit	Total SF
General Operating Rooms	General Surgery	2	350	700
Scrub Station Alcoves	2 sinks per station	1	50	50
Flash Sterilization	Shared between 2 OR's	1	60	60
MD Dictation Alcove	Stand-up Dictation	1	15	15
Stretcher Alcoves		2	30	60
Clean Utility/ Storage	Clean Surgical Supplies	1	120	120
Equipment Storage	Rolling Equipment	1	120	120
Anesth. Workroom	Bottle storage, Carts, Equip & charting	1	80	80
Blood Bank	UC Refrig & Workstation	1	60	60
Frozen Section Lab	Cryostat, Scope, Bench, UC Freezer	1	80	
Control Station	Nurse, Charting, Clerical	1	100	100
Men's Lockeroom/ Changing	40 lockers, sink vanity, gown storage	1	140	140
Men's Toilet	1 Toilet, Urinal & Shower	1	120	120
Women's Lockeroom/ Changing	40 lockers, sink vanity, gown storage	1	160	160
Women's Toilet	2 Toilet & Shower	1	100	100
Staff Lounge/ Conference	Seating, Table, Refreshments	1	120	120
Physician Dictation	Dictation cubicle	1	20	20
Janitor Closet	Near OR's	1	60	60
(All Prep/ Recovery Adjacent)				-
				-
Central Processing/ Storage	(Processing for procedures, not Endo)			-
Soiled Utility/ Decontamination	Soiled Instruments & Clean-up	1	60	60
Sterile Processing	2 Wash/ Decont, 1 Steam Sterile, Carts	1	160	160
Tray make-up	Instr storage, Tray make-up	1	60	60
Equipment Storage	General Medical equip	1	100	100
Clean Supplies	Clean supplies and bulk storage	1	140	140
Gas Storage	Bottle Storage	1	60	60
		Net SF		2,665
		Circulation 1.5		1,333
		Subtotal SF		**3,998**

Recovery Center

Room Name or Space Reqd.	Remarks	Units	SF/Unit	Total SF
Prep/ Recov & Dressing				
Change/ Prep/ Recovery Rooms	Prep/ Recov, Locker, sink & bed	4	135	540
Patient Toilets	H/C Access	1	55	55
Nurse Station/ Charting	Adjacent to Recovery N/S	1	100	100
MD Dictation		1	30	30
Meds and Utility	Shared w/ Recovery#1			-
Linen Storage		1	40	40
Storage		1	80	80
Patient discharge area	Direct discharge to auto pick-up	1	60	60
				-
Patient Recovery Area				-
Level 1 Recovery Stations	Partial walled cubicles	4	80	320
Patient Toilets	H/C Accessible	1	55	55
Nurse Station/ Charting	Adjacent to Recovery N/S	1	120	120
Patient Meds and Nourishment	Med dispensing & Refrig	1	40	40
Staff Office	Unit Mgr & Conf	1	100	100
Anesthesia Office	Office and Consult	1	100	100
Hallway alcoves	Stretcher/ Wheelchair	2	30	60
Clean Utility	Clean Linen & Storage	1	100	100
Soiled Holding		1	100	100
Storage	Carts and Equipment	1	120	120
Janitor Closet		1	60	60
Electrical Closet		1	60	60
		Net SF		2,140
		Circulation 1.5		1,070
		Subtotal SF		**3,210**

Women's Center

Room Name or Space Reqd.	Remarks	Units	SF/Unit	Total SF
Entry Area				
Entry Vestibule	Separate entry from Amb.Care	1	80	80
Reception Desk	2 Workstations, Copier, Fax	1	120	120
Waiting Area	Seats 18 & Coffee Cart	1	360	360
Toilet	H/C Access & Diaper Station	1	60	60
Women's' Resource Center	Books, Videos, Linked w/ Amb Care	1	300	300
				-
				-
Women's Dressing Area				
Consult Room	Counseling & Education	1	100	100
Changing Booths	Adjacent to Imaging and Exam Rooms	8	30	240
Patient Locker/ Storage	With Booths: 8 Full Lockers, 2 Seats	1	120	120
Toilet	H/C Toilet w/ vanity	2	60	120
				-
Exam/ Teaching				-
Exam Rooms	Private Hall to Changing Rooms	3	100	300
Exam/ Procedure w/ toilet	Private toilet w/ 2 doors	1	180	180
Control Station	Scale, Charting and Clerical	1	80	80
MD Work Area	Paperwork & Film Viewer	2	60	120
Storage	Clinical and general supplies	1	100	100
Staff Lounge/ Lockers	Common Locker/Lounge (See Imaging)			-
		Net SF		2,280
		Circulation 1.5		1,140
		Subtotal SF		**3,420**

Appendix C

Groundwater Assessment
Wilson Okamoto Corporation
July 2011

DRAFT
GROUNDWATER ASSESSMENT

KALOKO MAKAI

Kaloko and Kohanaiki, North Kona, Island of Hawai'i

Prepared for:
SCD – TSA Kaloko Makai, LLC

Prepared by:
Wilson Okamoto Corporation

July 2011

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1. GROUNDWATER RESOURCES ASSESSMENT

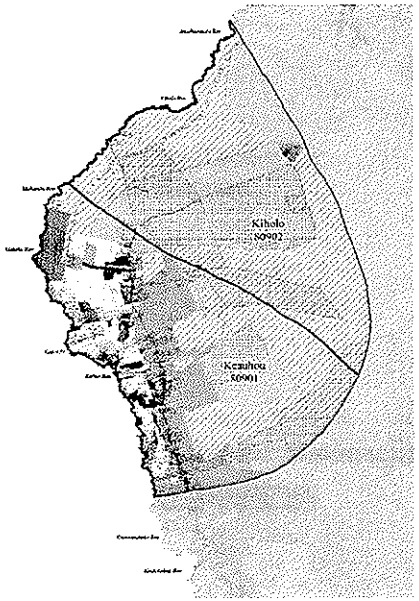
Wilson Okamoto Corporation prepared a groundwater resources assessment.

1.1. Groundwater Resources

The project site overlies the Keauhou Groundwater Aquifer System within the Hualālai aquifer sector (see Figure 1). Ground water occurs not only as a thin basal lens, but it also occurs as high-level groundwater (Bauer 2003).

From the shoreline inland to the near vicinity of Māmalahoa Highway, groundwater occurs in a thin and brackish basal lens that "floats" on saline groundwater beneath it and is in hydraulic contact with seawater at the shoreline.

Figure 1 Hualālai Aquifer; noting Kiholo and Keauhou Areas (From WUDP)



The basal lens between the Old Kona Airport and Keāhole Point is relatively saline, preventing it from being a significant source of irrigation supply unless it is extracted in small quantities from inland areas or it undergoes desalinization (Nance 2002). The thin basal lens is greatly influenced by ocean tides, suggesting that the brackish water lens is floating up and down on a long-term tidal signal (Bauer 2003).

The basal lens water does not meet the U.S. Drinking Water Standards even at the top of the lens. The groundwater lens in the Keāhole vicinity is brackish and discharges freely along the coast in a narrow band of a few feet wide in the intertidal zone (LUC-NELHA 1994).

Salinity, lens thickness and the diffuse transition zone are all indicative of a modest groundwater flow. An estimate of the regional mauka-to-makai rate of flow through the basal lens in this area, made by the U.S. Geological Survey (Oki et al., 1999), is three (3) million gallons per day (MGD) per coastal mile.

Somewhere in a generally linear alignment approximately coincident with Māmalahoa Highway, there is an abrupt change from basal to high-level groundwater of exceptionally low salinity.

Per the DLNR Engineering "Hydrogeologic Feasibility Study for a Water Development Shaft at Keōpu, 2007", the development of high-level water will not be affected by salt-water intrusion due to an undetermined impervious or low-permeability geologic structure that confines groundwater at high levels and impedes or prevents the interaction of high-level water with ocean tides and salt water intrusion (Lum 2007).

DWS' Kalaoa Well (4358-01) had a measured water level at 237.5± ft., mean sea level (msl) in 1990, the bottom elevation is –57 ft., msl. When the DWS' Hualālai Well (4258-03) was drilled 1.5 miles south of Kalaoa Well, the initial water level was 191± ft., msl when the bottom elevation of the well was –43 ft., msl (Bauer 2003).

After an initial aquifer test was performed, the well was deepened 99 ft. to –142 ft., msl. As a result, the water level in the well rose to 293± ft., msl. Deepening this well provides implications for ground-water flow in the high-level water body. The water level rise of 100 ft. suggests that the high-level aquifer is confined and that groundwater is under increasing artesian pressure the deeper a well is drilled (Bauer 2003).

The high-level groundwater of North Kona is of pristine quality, largely the result of the lack of saltwater intrusion and the lack of development on the lands above the wells. The chloride content (a measure of freshness of Hawai'i's groundwater) in the high-level wells range between 5 and 10 mg/L.

Attributes of high-level groundwater in the North Kona area are as follows:

- Water levels range from about 40 to 485 feet above sea level, with no consistent pattern that might show a lateral direction of high-level flow to the north or to the south.

- Chloride levels are typically less than 10 mg/l, essentially the same as found in high elevation rainwater.
- Compared to basal groundwater down gradient, temperatures are relatively warm, ranging from 69.8° to 73.8° F.
- Based on pump test results, permeabilities are less than found in the nearshore lavas but still sufficient to accommodate high capacity pumps of 500 to 1400 gallons per minute (gpm) (Nance 2008).

In addition to it creating a substantial reservoir of potable quality water, this subsurface feature also controls the location and manner of groundwater movement into the down gradient basal lens. While the hydraulic relationship between the two groundwater bodies is not yet understood, it is undoubtedly the reason for the anomalous characteristics of basal groundwater in the Keāhole to Kailua area (Nance 2008).

DWS' use of wells tapping high-level groundwater in this area began in 1994 with the North Kalaoa Well (No. 4358-01). The Queen Liliuokalani Trust Well (No. 4057-01) was added in January 1997 and use of two others (Nos. 4158-02 and 4258-03) began in late 1998. Use of Well 3857-01 at Wai'aha started in 2005. DWS' pumpage of these wells currently averages about 5.0-MGD (Nance 2008, Nance 2011).

Groundwater responses when these wells are ultimately used to their full capacity may shed light on the unknown aspects of this groundwater occurrence, including the geologic feature which creates the high level water, the hydraulic relationships among the differing high level groundwater compartments, and where, how and if the high level groundwater drains into the basal lens (Nance 2008).

Mid-level drilling by the State at the Ke'ōpū Monitor Well and by others at the neighboring Kamakana Villages site noted another groundwater phenomenon. Fresh water, hundreds of feet below the brackish basal lens and saline groundwater, was found at both locations. Both of the results suggest that the feature creating the high-level groundwater is layers of poorly permeable lava flows which confine the fresh water at depth.

The Ke'ōpū Monitor Well (3858-01) was drilled in 2001 at an elevation of 735 feet. It was drilled to a total depth of 1,310 ft. (-575 ft., msl) by CWRM for the purpose of monitoring the basal lens and underlying transition zone. The well encountered not only basal water with a head of 2.9 ft. and then subsequently high-level water under artesian pressure with a head in excess of 30-feet (Lum 2007). The Kamakana Villages well had similar results, but the fresh water at that location was encountered at greater depth (1060 ft. below sea level).

After completion of the Ke'ōpū Monitor Well, a water level measurement on December 4, 2001 was 27.26 ft., msl. When a water level transducer was installed into a sounding or chase tube set at a depth of 752 ft., the water level in the tube was 4± ft., msl. The two different water levels indicate that the well penetrates zones where ground water enters the well bore under artesian pressure (Bauer 2003).

Well 3858-01 penetrated both unconfined basal and confined high-level water, separated by an impervious or low-permeability formation of basaltic origin (Lum 2007). The video log does not clearly show the geologic nature or extent of the formation, but does show a large amount of fine material in roiling (vigorous and turbulent) water at -260 ft., msl, and uphole flow of water between -200 ft. and -400 ft., msl. (Lum 2007) The depth, inclination and geologic nature of the confining formation were not discernible from a study of both the video and driller's log. An interpretive hydrogeologic cross section, passing through the Ke'ōpu Deep Monitor Well, is shown in Figure 2.

1.1.1. Additional Information on the Cold Saltwater Circulation Below Basal Lens

Field evidence indicates intrusion of cold saline waters beneath the brackish groundwater lens between Keāhole Point and Ka'iwi Point, North Kona, Hawai'i (Bowles 2006). The shoreline lands between these two Points abut a pali, or steep underwater slope, which plunges rapidly to a depth of 5,000 feet within approximately 3 miles of the shore (see image below). It is well known that the Keāhole Point complex pumps its water from these depths, at temperatures on the order of 45° F (Bowles 2007) (see Figure 3).

A saltwater-circulation system exists beneath the basal lens (Cooper and others, 1964; Souza and Voss, 1987). Saltwater flows landward in the deeper parts of the aquifer, rises and then mixes with seaward-flowing groundwater (USGS 2011).

Ground water at Honokōhau Harbor occurs as a thin basal brackish water lens. If ground water is fresh («250 mg/L chloride concentration) then the Ghyben-Herzberg principle holds. That is, for every foot of water above sea level there is 40 feet of water below sea level. In a situation where the ground water is brackish, the ratio of 40: 1 becomes more like 30: 1 (Bowles 2006).

A salinity profile of the 'O'oma test well (State Well No. 4262-0 I) shows the 50 percent salinity at elevation -33± ft., msl (Waimea Water Services, 1996). Using the 30: 1 ratio for the thin brackish lens condition would put the Ghyben-Herzberg water level at approximately 1.3± ft., msl. The average of 38 instantaneous measurements at this well is 1.63 ft., msl (Bauer, 2003). However, this well is influenced greatly by ocean tides (Bowles 2006). In another well, Kaloko Irrigation Well No. 2 (State Well No. 4759-02), located 12,000 feet inland from the coast showed tidal and barometric amplitudes of on the order of 0.3 ft., the maximum tidal cycle (0.5 days) being 0.33 ft. over a 62 day period from December 7, 1994 to February 6, 1995

Figure 2 Interpretive Hydrogeologic Section at Ke'ōpū

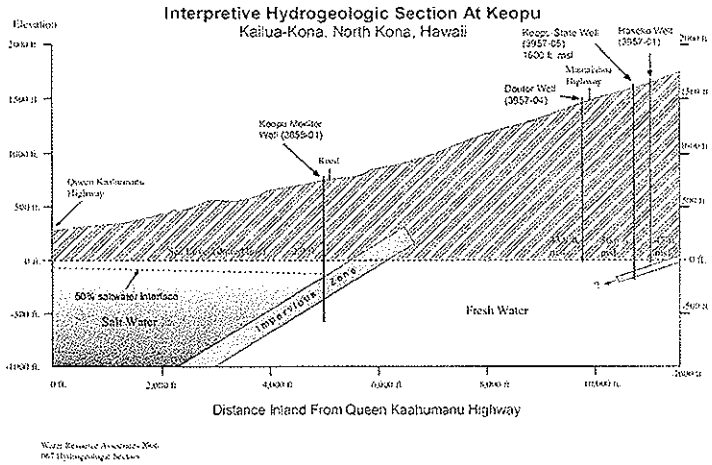


Figure 3 Cold Saltwater Intrusion, North Kona Slump

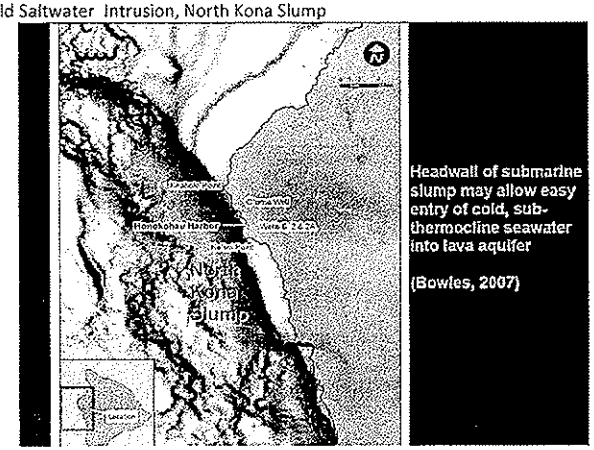


Image from PowerPoint Presentation by Hunt 2008, Noting Bowles 2007 Image

(Bauer, 2003; Waimea Water Services, 1996). Oki and others (1999) measured water levels at Kaloko Honokōhau National Historical Park as part of a numerical groundwater model and found tidal fluctuations within the test wells on the order of 0.5 to 1.5 feet daily (Bowles 2006).

The transmission of the tidal signal to water wells hundreds to thousands of feet inland is an indication of the high hydraulic conductivity (K) within the dike-free flank lava flows that comprise the Honokōhau region. Employing the tidal response in the Kaloko well, Bauer (2003) estimated the K value to be between 20,000 and 40,000 ft. per day (ft./d) (Bowles 2006).

Oki and others (1999) used a K value of 7,500 ft/d for dike-free basaltic lava flows while numerical modeling the groundwater flow system of Kona and the groundwater resources of Honokōhau National Historical Park, respectively. This value was picked as one that produced the smallest errors when groundwater heads were simulated (Bowles 2006).

Along the coast, within the Kaloko-Honokōhau National Historical Park, the ground-water flow system is composed of brackish water overlying saltwater. Ground-water levels measured in the Park range from about 1 to 2 feet above mean sea level, and fluctuate daily by about 0.5 to 1.5 feet in response to ocean tides (Oki et al. 1999).

Temperatures are anomalously cold and decrease progressively with depth into groundwater. Typical surface temperatures in basal groundwater in the Keāhole to Kailua area are 64° to 67° F. This is about 5° colder than the temperature of high-level groundwater directly inland. This difference, along with the progressive decrease in temperature with depth, show that the source of the low temperature is the saline groundwater beneath the basal lens (Nance 2002).

Salinity, temperature, water level and water quality data from basal wells in the area all indicate that the flow rate is low compared to areas to the north of Keāhole Point and south of Kailua Bay, that saltwater circulation at depth exerts considerable influence on temperature in the basal lens and that formation permeabilities are exceptionally high (Nance 2008).

However, equivalent temperatures in the ocean offshore can only be found at a depth of more than 700 feet. This means that cold seawater is drawn inland at depth and returns seaward at mid-depth, mixing with and cooling the basal groundwater. These low basal groundwater temperatures are unique along the West Hawai'i coastline (Nance 2008).

Figure 4 Concept of Ground-Water Convergence

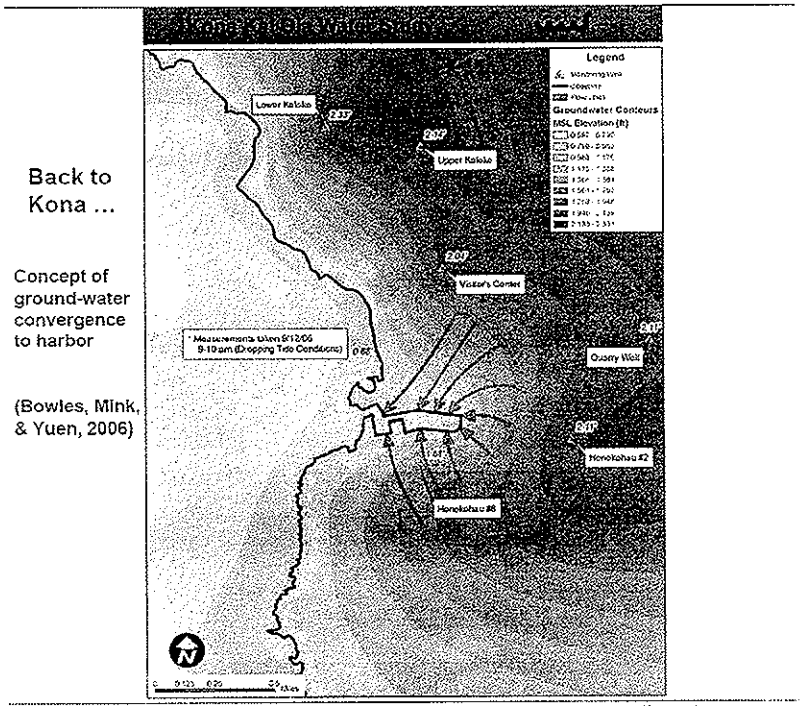


Image from PowerPoint Presentation by Hunt 2008, Noting Bowles 2006 Well Locations

1.1.2. Groundwater Use and Sustainable Yield

In 1967, the County Department of Water Supply (DWS) began pumping groundwater in West Hawai'i to supply the Kona Water System. Since then, the population and associated demand for groundwater has increased greatly (USGS 2011).

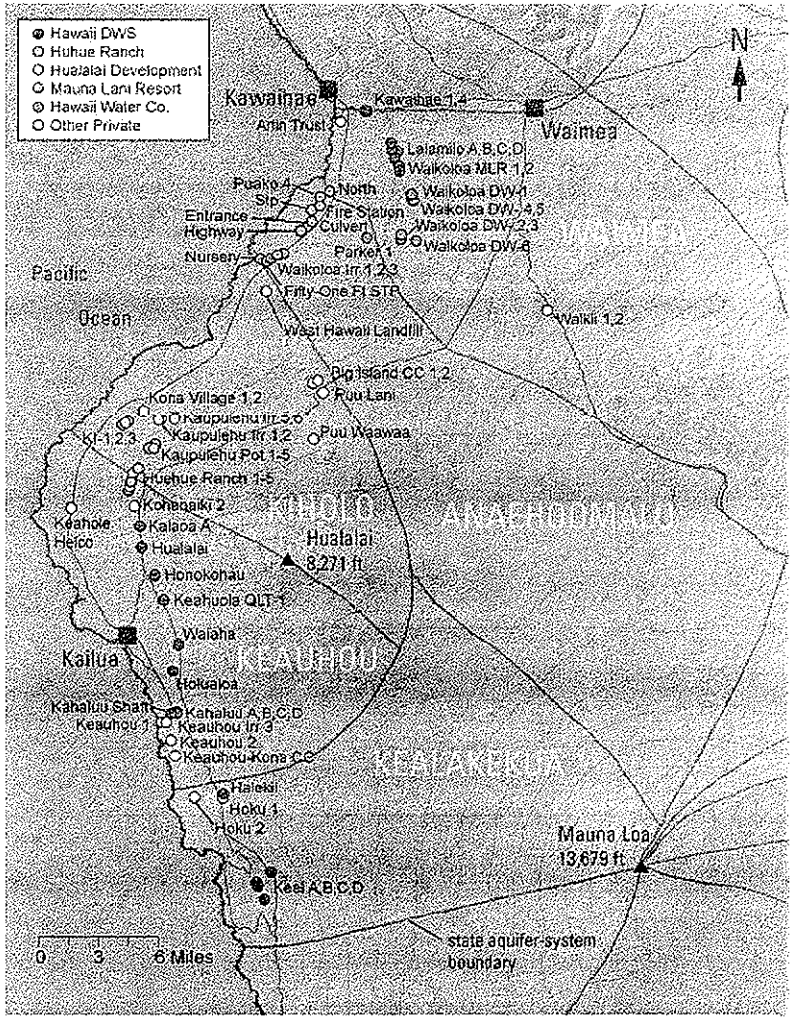
In 1990, the State of Hawai'i Commission on Water Resource Management established sustainable yield estimates for each of the aquifer system (Commission on Water Resource Management, 1990). For the Keauhou aquifer systems, the sustainable yield value is 38 MGD (USGS 2011).

It should be noted that the 38 MGD was based on the assumption that all groundwater in the Keauhou aquifer was basal. The subsequent discovery of high level groundwater may mean that the sustainable yield is substantially greater.

The 12-month moving mean of reported pumping in the Keauhou aquifer system as of February 2010 was 12.93 MGD, an increase of 1.25 MGD relative to the 12-month moving mean from the previous year (USGS 2011) (see Figure 6).

Table 1 is a chart prepared by USGS noting Keauhou aquifer system number of wells with reported pumpage, reported pumpage and 12-month moving mean of total pumpage, 1984 to present.

Figure 5 USGS Map noting Well Locations



(USGS 2011)

Table 1
Well Production and Sustainable Yield in Hualālai Sector

System Area	High 12-Month MAV	Potential 16-Hr Production	Potential 24-Hr Production	Sustainable Yield	High 12-Month MAV	Potential 16-Hr Production	Potential 24-Hr Production
	(MGD)	(MGD)	(MGD)	(MGD)	SY (%)	SY (%)	SY (%)
Hualālai							
Keauhou	11.49	16.58	24.87	38	30.24	43.63	65.45
Kiholo	4.06	16.21	24.31	18	22.56	90.06	135.06

Source: *Hawai'i County Water Use and Development Plan Update, Final Report*, 2010
MAV = moving average
SY = sustainable yield

Present water use is 30 percent of the Keauhou Aquifer's area sustainable yield.

Figure 6 USGS Chart Noting Pumpage in Keauhou Aquifer (USGS 2011)

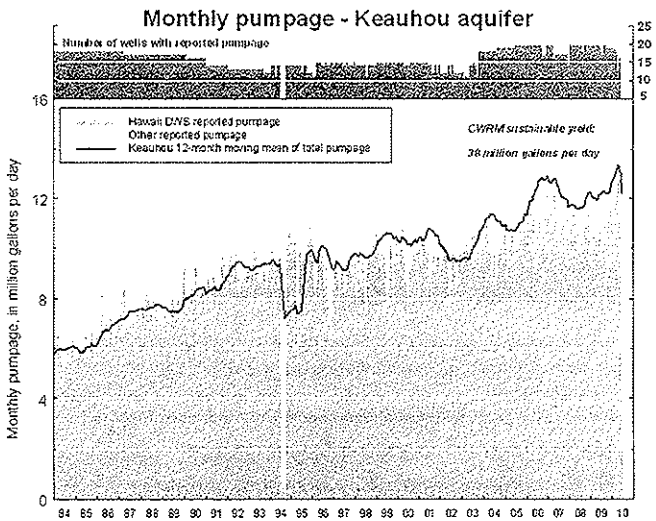


Table3 Existing Water Uses in Keauhou Aquifer System Area			
CWRM Water User Category	**Water Use (MGD)**	**Percent of Total w/o Ag**	**Percent of Total w/ Ag**
Municipal			
DWS System	9.44	83.4	78.5
Private Public Water System	0.48	4.2	4.0
Agriculture	0.71	0.0	5.9
Domestic	0.35	3.1	3.0
Irrigation	0.38	3.4	3.2
Reclaimed Wastewater	0.59	5.2	4.9
Industrial	0.07	0.6	0.6
Military	0.00	0.0	0.0
Total w/o Agriculture	11.31	100.0	
Total w/ Agriculture	12.02		100.0
Source: Hawai'i County Water Use and Development Plan Update, Final Report, 2010			

While reference to maximum densities permitted in the General Plan suggest an "over utilization" of the resource, the County DWS projects consumption in 5-year increments to the year 2025 based on historical consumption data from 1970 to 2003. This anticipated consumption is charted in Tables 4 and 5 and graphically depicted in Figure 7.

Table4 Water Demand Projection – Keauhou Aquifer System Area [80901]										
	Without Agricultural Demands					**With Agricultural Demands**				
GROWTH RATE A	**2005**	**2010**	**2015**	**2020**	**2025**	**2005**	**2010**	**2015**	**2020**	**2025**
Total	11.3	12.6	13.9	15.4	17.1	12.0	13.4	14.8	16.4	18.2
Potable	10.3	11.4	12.6	14.0	15.5	10.3	11.4	12.6	14.0	15.5
Nonpotable	1.0	1.2	1.3	1.4	1.6	1.7	1.9	2.2	2.4	2.6
GROWTH RATE B	**2005**	**2010**	**2015**	**2020**	**2025**	**2005**	**2010**	**2015**	**2020**	**2025**
Total	11.3	12.6	14.1	15.7	17.5	12.0	13.4	15.0	16.7	18.6
Potable	10.3	11.5	12.8	14.3	15.9	10.3	11.5	12.8	14.3	15.9
Nonpotable	1.0	1.2	1.3	1.4	1.6	1.7	2.0	2.2	2.4	2.7
GROWTH RATE C	**2005**	**2010**	**2015**	**2020**	**2025**	**2005**	**2010**	**2015**	**2020**	**2025**
Total	11.3	12.9	14.6	16.4	18.5	12.0	13.7	15.5	17.5	19.7
Potable	10.3	11.7	13.2	14.9	16.8	10.3	11.7	13.2	14.9	16.8
Nonpotable	1.0	1.2	1.3	1.5	1.7	1.7	2.0	2.3	2.5	2.9
Source: Hawai'i County Water Use and Development Plan Update, Final Report, 2010										

Figure 7 DWS Water Demand Projection – Hualālai Aquifer Sector Area

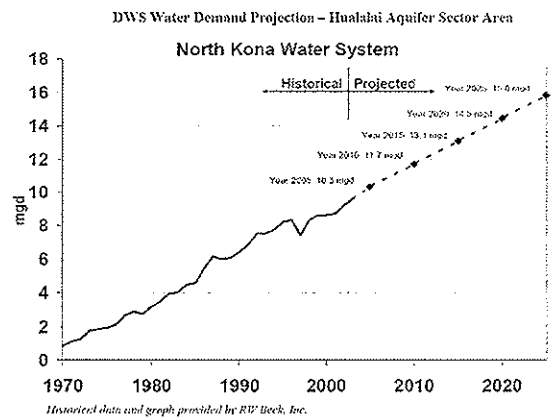


Table 5 DWS Water Use Projections for Keauhou Aquifer System, 2005 to 2025						
Sustainable Yield (MGD)	**DWS Users**	**DWS Projected Water Use (MGD)**				
38		**2005**	**2010**	**2015**	**2020**	**2025**
	With Ag	12.0	13.4	15.0	16.7	18.6
	Without Ag	11.3	12.6	14.1	15.7	17.5
Source: Hawai'i County Water Use and Development Plan Update, Final Report, 2010						

The WUDP identifies desalination as a viable alternative. Preferable locations for desalination facilities would be at moderate ground elevations to reduce drilling and pumping costs, and outside the influence of potable water wells. As most of the potable wells are located on a band mauka of Māmalahoa Highway, the area between Queen Kaahumanu Highway and Māmalahoa Highway might be a suitable location for brackish water wells (WUDP 2010).

The water utility courses of action for North Kona, as put forth in the Hawai'i County General Plan, are as follows:

(a) Continue to pursue groundwater source investigation, exploration and development in areas that would provide for anticipated growth and an efficient and economic system operation;
(b) Continue to evaluate growth conditions to coordinate improvements as required to the existing water system in accordance with the North Kona Water System Mater Plan
(c) Explore and develop a well in Wai`aha

On September 25, 2008, *Mapping the Future: Kona Community Development Plan Volume 1* (Kona CDP) serves as a policy guide for County decisions regarding physical development. It establishes a physical framework for future growth by identifying the County's major policies concerning the type and location of future development in order to meet the goals and objectives of the Kona CDP.

Per the Kona CDP, most of the future growth in Kona will be directed to the Urban Area (UA). Within this Kona Urban Area, growth would be directed to compact villages located along proposed transit routes or to infill areas within, or adjacent to, existing development. The general locations of these villages are within the Transit-Oriented Developments (TODs). The Official Kona Land Use Map defines the Kona Urban Area and the general locations, spacing and type of TOD villages.

The Kona CDP anticipated that a project such as Kaloko Makai would be planned and developed on the subject site. Implementation of the Project will not result in withdrawals in excess of sustainable yields nor preclude other planned uses.

The Land Use section of the Kona CDP serves as policy guide for County decisions regarding physical development. It establishes a physical framework for future growth by identifying the County's major policies concerning the type and location of future development in order to meet the goals and objectives of the Kona CDP.

Most of the future growth in Kona will be directed to the Urban Area (UA.) Within this Kona Urban Area, growth would be directed to compact villages located along proposed transit routes or to infill areas within, or adjacent to, existing development. The general locations of these villages are within the Transit-Oriented Developments (TODs). The Official Kona Land Use Map defines the Kona Urban Area and the general locations, spacing and type of TOD Villages.

The Planning Director, Planning Commission and County Council shall review TOD applications with a rebuttable presumption that the project furthers the intent of Chapter 25 Zoning Code and is consistent with the goals, objectives and policies of the County General Plan and Kona CDP, provided that the proposed location is generally consistent with the Official Kona Land Use Map and the master plan consistent with the Village Design Guidelines.

Transit-Oriented Development (TOD) is defined in the Kona CDP as the development of compact, mixed-use villages that offer increased density and integrate housing, employment, shopping, and recreation opportunities.

The Kaloko Makai site was designated as one of the Neighborhood TODs on the Official Kona Land Use Map. As noted, Kaloko Makai also proposes to incorporate a regional hospital into the development. Consistent with the Kona CDP economic policy ECON-1.1, that means the Neighborhood TOD at Kaloko Makai would automatically be designated a Regional Center TOD.

Kaloko Makai will be a compact, mixed-use village that integrates diverse housing offerings, mixed-use commercial and retail growth and employment opportunities, and a range of community services and facilities (inclusive of medical, judiciary, lodging, and civic uses as well as recreational opportunities). Kaloko Makai will be a "Transit Oriented Development" (TOD) and "Traditional Neighborhood Design" (TND) community consistent with the Guiding Principles and Elements of the Kona Community Development Plan.

1.2. Stormwater Collection and Disposal

Due to high permeabilities of the natural ground surface across the project site and on the upslope lands, surface runoff does not occur on the Kaloko Makai project site even during the most intense rainfalls. As a result, no natural gulches or waterways have been created. Natural drainage of the project site consists of rainfall percolating through the layers of very porous lava to the ground-water table.

With no surface runoff, all rainfall which is not lost to the atmosphere via evaporation or plant evapotranspiration becomes groundwater recharge. This amount is about one-third to one-half of the 20 to 30 inches of rain each year.

Stormwater over the site to be developed will either percolate directly into the ground (in natural and landscaped areas) or will be collected in a system of catch basins and drain lines and disposed of in drywells located throughout the developed area.

In the vicinity of the project site, there are two existing culverts under Queen Ka'ahumanu Highway. These appear to be sized and placed to address roadway runoff and are not part of any regional drainage system associated with mauka properties

The drainage system along Hina Lani Street consists of roadside swales with disposal in drywells. Kaloko Makai proposes a 100-foot wide natural greenbelt that will adjoin the north side of Hina Lani Street, from Ane Keohokālole Highway to Queen Ka'ahumanu Highway. In addition, the makai district-scale park may serve as a collection basin for any excess water.

There are no wetlands located within the project site. The Kaloko-Honokōhau National Historic Park has wetlands approximately 1/2-mile down gradient from the project site.

1.3. POTENTIAL IMPACTS AND MITIGATION MEASURES

Potential water quality impacts during construction of the project will be mitigated by adherence to State (HAR Chapters 11-54 and 11-55, as applicable) and County water quality regulations governing grading, excavation and stockpiling. The County's grading ordinance includes provisions related to reducing and minimizing the discharge of pollutants associated with soil disturbing activities in grading, grubbing and stockpiling.

BMPs will be utilized in compliance with County ordinances pertaining to grading, grubbing, stockpiling, soil erosion and sedimentation during construction. BMPs will also be implemented for long-term development and operation of activities occurring on the site as part of pollution prevention measures.

Appropriate BMPs are filtration or infiltration measures, including flow-through based treatments such as filters, vegetated swales and other media filters and infiltrators. These require that surface flow be passed through soil or suitable media capable of filtering pollutants prior to discharge or release into the groundwater. Vegetated swales consisting of suitable native plants, grass or ground cover could be installed to provide flow-through treatment (LUC TSA 2002).

Most potable supply that does not become wastewater would be used for landscape irrigation and dust control. A lesser amount would also be used for wash-downs of pavement areas and other miscellaneous uses outside of buildings. Most of this water would be lost to plant evapotranspiration or direct evaporation, but some would percolate to groundwater.

Percolation of Irrigation/External Water Uses – Sources of irrigation water for Kaloko Makai will come from recovered R-1 treated wastewater and from the potable system. It is assumed that 10-15% of applied irrigation water will percolate down to the basal ground water. As the excess irrigation water percolates downward through the unsaturated zone to the groundwater, natural removal of nitrogen and phosphorus from the water will be significant.

Storm and Surface Water Runoff – Potential water quality impacts during construction of the project will be mitigated by adherence to State (HAR Chapters 11-54 and 11-55, as applicable) and County water quality regulations governing grading, excavation and stockpiling. The County's

grading ordinance includes provisions related to reducing and minimizing the discharge of pollutants associated with soil disturbing activities in grading, grubbing and stockpiling.

BMPs will be utilized in compliance with County ordinances pertaining to grading, grubbing, stockpiling, soil erosion and sedimentation during construction. BMPs will also be implemented for long term development and operation of activities occurring on the site as part of pollution prevention measures.

Prior to the occupancy of any residential or commercial unit within the Project, Kaloko Makai shall implement and maintain storm and surface-water runoff best management practices, subject to any applicable review and approval of the State of Hawai'i Department of Health (DOH), designed to prevent violations of State water quality standards as a result of storm-water discharges originating from the Project.

Upon the first to occur of: the issuance of final subdivision approval for the first single-family residential unit within the Project; or the issuance of Final Plan Approval for any commercial or multi-family unit within the Project, Kaloko Makai shall record in the Bureau of Conveyances of the State of Hawai'i (the "Bureau") against the Property a Declaration of Covenants, Conditions and Restrictions for Storm Water and Surface Water Run Off.

The project's proposed drainage system will be designed to minimize impacts to near shore coastal waters. Water quality treatment and detention basins will be built to prevent runoff and sedimentation from impacting groundwater resources. Innovative and more natural ways to handle drainage improvements will be sought to comply with the County drainage standards.

Pollution Prevention Plan (PPP) - Kaloko Makai shall develop a pollution prevention plan (PPP) that provides Best Management Practices (BMPs), including structural BMPs, for pollution prevention that address all categories of permitted uses within the Project, and shall address environmental stewardship and the non-point sources of water pollution that can be generated from any uses allowed within the Project. Emphasis shall be given to BMPs that prevent or limit pollutants arising out of the permitted uses within the Project from reaching the groundwater and ocean.

1. The PPP shall be consistent with the Declaration Regarding Pollution Prevention Plan for West Hawai'i Business Park, dated June 18, 2008 and recorded in the Bureau as Document No. 2008-102908.

2. The PPP shall include such information on the National Park and the nationally significant cultural and natural resources within the National Park as provided by the NPS.

3. PPP Approval:

    a. At least ninety (90) days prior to the start of construction within the Property, e.g., activities taken pursuant to a grading permit issued pursuant to Chapter 10, Hawai'i County Code ("Grading Activity"), Kaloko Makai shall submit the PPP to the Director of the County of Hawai'i Planning Department (the "Planning Director") for review and approval, contingent upon the Planning Director's acceptance of such an

approval role (the "County of Hawai'i Planning Department Approval"). At least sixty (60) days prior to submitting the PPP to the Planning Director, Kaloko Makai shall provide a draft PPP to NPS for review and comment. NPS shall provide comments and/or requests for changes to the PPP within thirty (30) days of receipt. To the extent that Kaloko Makai does not accept NPS's comments or changes, Kaloko Makai shall provide such NPS comments and changes to the Planning Director at the time it submits the PPP for Planning Director Approval.

b. In no event shall Kaloko Makai start Grading Activity on the Property until the PPP is approved by the Planning Director, as applicable.

Control of contaminated surface water can be achieved through the development of a PPP designed to address all pollutants associated with the development and to identify measures that will contain and treat such pollutants in order to prevent any release into the environment, including the groundwater (LUC-Lanihau 2003). There will be no anticipated adverse impact on groundwater quality from the development of this project.

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Appendix D

Nearshore Marine Environment Assessment
Wilson Okamoto Corporation
July 2011

DRAFT
NEARSHORE MARINE ENVIROMENT ASSESSMENT

KALOKO MAKAI

Kaloko and Kohanaiki, North Kona, Island of Hawai'i

Prepared for:
SCD – TSA Kaloko Makai, LLC

Prepared by:
Wilson Okamoto Corporation

July 2011

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Wilson Okamoto Corporation prepared nearshore marine environment assessment in consultation with Marine Research Consultants, Inc.

1. PONDS AND NEARSHORE MARINE ENVIRONMENT

Although not located on the coastline, the Kaloko Makai project still has the potential to affect chemical and biological process in the nearshore marine environment. As a result, it is important to provide a characterization of the nearshore marine system in order to establish a baseline that can be used in the future to evaluate changes that may occur because of the Kaloko Makai project.

The main structural feature of the shoreline downslope of Kaloko Makai is an extensive beach that extends the length of the Kaloko-Honokōhau National Historical Park. Seaward of the shoreline, the nearshore zone is composed of a wide basaltic ledge of pāhoehoe lava with interspersed pockets of white calcareous sand. The intertidal platform, which is constantly subjected to the wash of waves, is flooded in places to form tidepools.

Rimming many of the shoreline pools formed in the basalt bench are dense bands of the intertidal seaweeds. The submerged portions of the intertidal pools are lined with various forms of encrusting red algae, and contain numerous urchins, as well as numerous juvenile reef fish.

Beyond the shoreline, the structure of the offshore environment generally conforms to the pattern that has been documented as characterizing much of the west coast of the Island of Hawai'i. The zonation scheme consists of three predominant regions.

Beginning at the shoreline and moving seaward, the shallowest zone beyond the shoreline is a relatively flat basaltic shoreline bench, covered with scattered basaltic boulders.

Seaward of the platform boulder zone, bottom structure is composed predominantly of a gently sloping reef bench composed of basalt, interspersed with lava extrusions and sand channels. In some areas, the bench is characterized by high relief in the form of undercut ledges and basaltic pinnacles.

Fine-grained calcareous sediment also comprises a component of bottom cover. Water depth in this mid-reef zone ranges from about 6 to 15 m.

As wave stress in this region is substantially less than in the shallower areas, and suitable hard substrata abound, the area provides an ideal locale for colonization by attached benthos, primarily reef corals. As in most areas of West Hawai'i, the most diverse coral communities on the reef are found in the mid-reef zone.

The seaward edge of the reef platform (at a depth of about 18 m) is marked by an increase in slope to an angle of approximately 20-30 degrees. In the deep slope zone, substratum changes from the solid continuation of the island mass to an aggregate of generally unconsolidated sand and rubble.

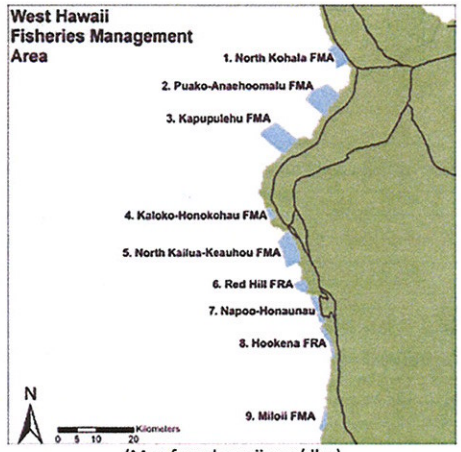
Moving down the reef slope, coral settlement and growth cease at a depth of approximately 25 m; beyond this depth, the bottom consists mostly of sand, with occasional basaltic outcrops.

The Kaloko-Honokōhau National Historical Park is located makai of the proposed Kaloko makai project. Contained within the park boundaries are two large fishponds (Kaloko and 'Aimakapā), tidal areas and wetlands.

Half of the park at Kaloko-Honokōhau is under the sea. These waters are exceptionally clear and are noted for their biodiversity. The coral reef is home to many different fishes, invertebrates and marine algae. The reef can be accessed by several dive boats operating from Kailua-Kona and great snorkeling can be found in the waters near ?Ai?opio Fishtrap.

Waters of Kaloko Honokōhau National Historical Park are one of nine individual fishery management areas (FMAs) on the west coast of the Big Island, HAR 13-60.3, see Figure 1.

Figure 1 West Hawaii Fisheries Management Area



(Map from hawaii.gov/dlnr)

1.1. Ponds

Hawaii Administrative Rules, Title 11, Department of Health, Chapter 54, Water Quality Standards, §11-54-1, Definitions, define "Anchialine pools" as coastal bodies of standing waters that have no surface connections to the ocean but display both tidal fluctuations and salinity ranges characteristic of fresh and brackish waters, indicating the presence of subsurface connections to the water table and ocean. Anchialine pools are located in porous substrata (recent lava or limestone) and often contain a distinctive assemblage of native aquatic life. Deeper anchialine pools may display salinity stratification, and some shallow pools may contain standing water only on the highest tides.

The following contains a summary of analysis conducted in 2002 that characterized the marine and fishpond environments at the Kaloko Honokōhau National Historical Park. All information in this section is from (Marine Research Consultants 2002), unless otherwise noted.

Water samples were collected on transects that bisected each fishpond to obtain baseline information on the composition and stratification of pond waters. Transects extended from the most landward shoreline of the ponds, through the approximate center of the ponds to the seaward shorelines, and then continued into the ocean for a distance deemed to reach open coastal ocean.

In addition, groundwater and other water samples were collected from a variety of sources. These included: 1) high level potable quality wells that are part of the Department of Water Supply (DWS) North Kona system; 2) Basal wells of brackish water quality, primarily three monitoring wells located on Kaloko-Honokōhau National Historical Park property; 3) basal wells of saline quality, primarily located on the property of NELHA; and 4) springs where groundwater discharge was evident along the periphery of Kaloko and 'Aimakapā Ponds.

Data was collected during several periods. The first set of water samples was collected in May-June 2000 in both 'Aimakapā and Kaloko Pond. Subsequently, a second set of samples was collected in December 2001 only in 'Aimakapā Pond. In addition to the water samples collected specifically for this report, data collected as part of the Comprehensive Environmental Monitoring Program (CEMP) at NELHA was also utilized.

1.1.1. Water Chemistry

Water in the National Park ponds is brackish, consisting of a mixture of low salinity groundwater, and seawater. As a result, water chemistry in the ponds can potentially be influenced by changes in groundwater composition and runoff of surface water. Leaching of materials such as fertilizer nutrients and pest control agents to groundwater could alter pond water chemistry. In addition, as pond water exchanges with ocean water in the nearshore area, there is also potential for alteration of marine water chemistry. Such alterations in water chemistry can, in turn, provide the potential to affect the structure of marine biotic communities in the nearshore area. (Marine Research Consultants 2002)

Probably the most obvious characteristic of the data set is the major differences between water quality in 'Aimakapā and Kaloko Ponds. These differences in water chemistry are primarily the result of differences in physical structure of the barriers between the ponds and the ocean.

'Aimakapā pond is separated from the ocean by a fairly wide (~20 m) continuous sand berm that is not very permeable to exchange between the pond and the ocean. Such impermeability is apparent in the sharp, nearly vertical gradients at the shoreline of many of the water chemistry constituents (e.g., Salinity, Si (Silica), TN (Total Nitrogen), TP (Total Phosphorous), TON (Total Organic Nitrogen), TOP (Total Organic Phosphorous) in 'Aimakapā Pond. Kaloko Pond is separated from the ocean by a man-made rock wall that was undergoing reconstruction at the time of water sampling.

Compared to the sand berm, the rock wall that separates Kaloko Pond from the ocean is very permeable, and exchange of water between the ocean and pond is enhanced by channels

("mākāhā") constructed into the wall. It should be noted that these direct connections between the pond and ocean eliminate Kaloko Pond from the designation of "anchialine" which requires that no such connections exist. As a result of the increased water exchange between Kaloko Pond and the ocean, there are no sharp gradients of water chemistry constituents at the marine shoreline.

While both ponds contain thick sediment bottoms, there is a substantial difference in the quality of the sediment. Bottom composition of 'Aimakapā Pond consists of soft flocculent silty mud that is easily penetrable for at least one meter. Bottom composition of Kaloko Pond is a hard sand/mud mixture that is largely covered with marine algae, primarily the introduced species *Acanthophora specifera*. Sand/mud bottoms in both ponds were distinctly anaerobic beneath the surface layer as evidenced by the strong odor of H_2S when the bottom was even slightly disturbed.

1.1.2. Horizontal and Vertical Stratification

In 'Aimakapā Pond, surface water increased in salinity from mauka to makai by 0.4 ppt (parts per thousand) in summer 2000 and 0.3 ppt in winter 2001. There was only the slightest hint of vertical stratification between surface and bottom water in 'Aimakapā Pond with the largest difference between salinity of surface and bottom water at any site 0.12 ppt in 2000 and 0.3 ppt in 2001.

Vertical stratification of Kaloko Pond was slightly greater, with bottom water on the order of 0.1 to 0.9 ppt higher than surface water.

The overall salinity between the two ponds, however, varied to a large extent. Salinity in 'Aimakapā Pond was approximately 13 ppt during both summer and winter, while salinity in Kaloko Pond was 32-33 ppt. As seawater has a salinity of approximately 35 ppt, the composition of water in 'Aimakapā can be estimated as about 37% seawater and 63% freshwater (not factoring in evaporative loss).

On the other hand, based on salinity, the composition of Kaloko Pond consists of about 93% seawater and 7% freshwater. Similar measurements made by Marine Research Consultants in 1996 of Kaloko pond revealed that salinity was approximately 6 ppt lower (~29 ppt) in surface pond water than in ocean waters. Comparison of these data suggests that salinity of the pond has increased in recent years. The open channels in the rock wall allowing free exchange of water between the ocean and pond is likely the source of the increased salinity.

Comparing values of salinity within the ponds to salinities of springs around the perimeter of the ponds shows spring water at 'Aimakapā Pond is near the same salinity as pond water (13-17 ppt), while springs around Kaloko Pond have substantially lower salinities than the pond (9-14 ppt). These comparisons again point to the open circulation between Kaloko Pond and the ocean. Water from groundwater monitoring wells located landward of the ponds all had lower salinities than any of the pond waters

Typically, in nearshore surface ocean waters of West Hawai'i, there is a pattern of decreasing salinity with distance from shore. This gradient is indicative of low salinity groundwater entering the ocean near the shoreline and mixing with high salinity ocean water. A somewhat unusual finding is that the lowest salinities in the ocean samples were not found nearest to the shoreline off of either

fishpond. Rather, the lowest salinities were measured in surface ocean samples approximately 25-50-m offshore. Consistent results suggest that groundwater flow to the ocean is primarily around the pond boundaries, rather than through the shoreline barriers that separate the ponds from the ocean.

Horizontal and vertical stratification of salinity in the ocean samples was evident at all stations during all surveys. Beyond 25-50 m from shore, with increasing distance from shore, salinity increased at all stations in both surface and bottom water. The difference in salinity between surface and bottom water samples was greater in the ocean than in either pond.

As a result of the differences in permeability between the two ponds and the ocean, the patterns of dissolved nutrients vary considerably between ponds. The pattern prescribed by the concentrations of dissolved Silica (Si) on transects are essentially a mirror image of salinity during both the summer 2000 and winter 2001 sampling events. Such a pattern reflects the two orders of magnitude difference in concentrations of Si between groundwater and ocean water. In addition, the mirror image of Si and salinity indicates that Si is a "conservative" tracer, in that it is not utilized to any measurable extent by biotic or chemical reactions within the ponds and ocean. As a result, there is the same large variation in concentration of Si between the ponds, and same degree of stratification of Si as was evident in salinity.

Throughout Kaloko Pond there was little variation in nutrient concentrations. Concentrations of NO_3^-, Si, PO_4^{3-} and NH_4^+ were also consistently lower than the peak concentrations in the offshore ocean 25-50 m from the shoreline.

In 'Aimakapā Pond, the situation is substantially different. In addition, gradients of nutrients were very different between winter and summer. With the exception of NO_3^- and NH_4^+, water in 'Aimakapā Pond in summer 2000 had distinctly higher concentrations of nutrients compared to ocean water samples collected directly offshore of the ponds. NO_3^- in Aimakapā Pond is similar to Kaloko Pond, with consistently lower values in the pond relative to the ocean in summer 2000.

As with salinity, the distinct discontinuities between concentrations of nutrients between the seaward end of the ponds and the nearshore ocean indicate that the sand berm is an effective barrier impeding free exchange between the pond and ocean. As a result, while separated by a horizontal distance of only about 20-m, water in 'Aimakapā Pond and the nearshore ocean display very different nutrient characteristics with little apparent connection. The gradients in Kaloko Pond were far less pronounced, as the rock wall and associated channels provide far more mixing capability between the pond and the ocean.

1.1.2.1. Conservative Mixing Analysis

A useful treatment of water chemistry data for interpreting the extent of material input from land is application of a hydrographic mixing model. In the simplest form, such a model consists of plotting the concentration of a dissolved chemical species as a function of salinity. This method of data interpretation has recently been adopted by the State of Hawaii Department of Health as a new protocol for evaluating compliance with water quality standards in West Hawaii.

All of the concentrations of NO_3^- in the ponds lie far below the mixing line, suggesting that there is substantial uptake of NO_3^- within the ponds. Uptake is most evident in 'Aimakapā Pond, where the concentrations of NO_3^- are near the detection limit. While the actual concentrations of NO_3^- are slightly lower in Kaloko Pond compared to 'Aimakapā Pond, the difference in distance between the data points and the conservative mixing line indicate that there is substantially more uptake of NO_3^- in 'Aimakapā Pond than in Kaloko Pond.

Because TOP and TON occur in very low concentrations in both open ocean water and high-level groundwater, the conservative mixing lines for these constituents are essentially flat. However, data points of TOP and TON occur far above the conservative mixing lines. This pattern likely reflects the metabolic cycling conversion of inorganic nutrients to organic nutrients by plant metabolism and decomposition within 'Aimakapā Pond.

The anomalously high concentrations of TOP and TON in wells and springs in the Kaloko-Honokōhau area are curious, as these compounds are associated with biotic activity that is not usually possible within the water table. TON and TOP are also not components of fertilizers, so the occurrence in wells is not a result of leaching of these materials to groundwater. The highest concentrations of TON and TOP, and lowest concentrations of NO_3^-, are found in KAHO Monitoring Well 1 (4060-01) located directly behind 'Aimakapā Pond. These high concentrations of organic N and P, and low concentrations of inorganic N suggest that water from the pond is being carried landward by tidal action to the region of the monitoring wells.

Such a theory is supported by the results shown in TNWRE (2002) who has demonstrated that the difference in a tidal phase in 'Aimakapā Pond and groundwater in the volcanic formation around the pond is so pronounced that it causes a gradient reversal between the pond and surrounding groundwater on virtually all changes of the tide.

When groundwater level is higher than the level in the pond, groundwater flows into the pond; when pond level is higher than groundwater, water flows out of the pond back into the surrounding volcanic formation. This flow reversal appears to reach as far inland as KAHO Monitoring Well 1, which is approximately 900 feet inland. Hence, the anomalously low concentrations of NO_3^- and high concentrations of TON and TOP in Well 1 are likely a result of landward transport of Pond water. Mixing plots of TP and TN reflect the combined effects of inorganic and organic N and P, with data points above the mixing lines from most of the sources of groundwater.

1.1.2.2. Pond Metabolism

The major concern regarding impacts to the pond resources at the KAHO from upland development is the effect that increased nutrient loading will have on pond metabolic function. The perception is that increases in nutrient concentrations to groundwater flowing from the development site to the National Park will alter the ponds in an undesirable manner. In order to estimate the magnitude of such changes, pond metabolism was estimated using measured changes in dissolved oxygen concentration in 'Aimakapā Pond over a one-week period in December 2001. Deployment of an instrument capable of continuously logging dissolved oxygen and temperature at five-minute intervals produced a record of approximately 2,000 data points for each variable.

Review of the data logs revealed that oxygen concentrations and temperature track exceptionally well. The highest daylight temperatures correspond to the peak oxygen concentrations in mid-afternoon. The temperature and oxygen lows occur just prior to dawn. Peak oxygen concentrations of 11 mg/L at 27.5° correspond to saturation of about 140% while lows of oxygen concentration of 2.5 mg/L at 23° correspond to a saturation of about 33%. Of interest is that the daily amplitude of the peaks and lows for each day is similar with the exception of December 30, 2001, when peak temperature and oxygen were lower than the remainder of the data set. Weather conditions on this day consisted of heavy rainfall, with little direct sun. All other days were sunny.

This pattern indicates that pond metabolism is dominated by daylight photosynthesis and dark respiration according to molar relationships defined in the Redfield equation.

Comparing groundwater nutrient loading to the pond with gross production/respiration within the pond indicates that only approximately 4% of the pond metabolism can be supported by "new" nutrients delivered to the pond by groundwater flux. The remaining 96% of nutrient uptake must therefore be supported by recycling of nutrients within the pond. It is likely that the actual percentage of nutrient recycling is even higher (~99%) than the estimate as it is clear from all available data that groundwater flow into the pond is substantially restricted.

1.1.2.3. Salinity

With respect to impacts to natural resources due to this nominal salinity increase, prior studies note varying levels of salinity in coastal ponds that may vary seasonally or from place to place within a pond, both vertically and horizontally, for example, with the amount of tidal flushing and downpours of fresh water (Montgomery 2009 - referencing Maciolek & Brock 1974.)

Salinity levels within fishponds and anchialine pools naturally vary from place to place within a pool or pond, both vertically and horizontally. Maciolek and Brock (1974) found that salinity levels within anchialine pools vary depending on tides; for example, in their study they noted that a pond at low tide had a bottom salinity of 6 ppt, then 25 ppt at the following high tide. Knee, Street, Grossman, and Paytan (2008) recognized variations in salinity levels between different fishponds and anchialine pools and also observed tidal-cycle variations in salinity in fishponds and anchialine pools. (Terry 2009)

According to Maciolek and Brock, in their report *Aquatic Survey of the Kona Coast Ponds*, "(b)ecause salinity is a characteristic of anchialine waters and has an important influence on the distribution of many aquatic species, considerable attention was given to this factor."

"(N)o single water exposure can be characterized by one salinity value or fixed range because of temporal fluctuations. Short-term variations occur with tidal changes and direct rainfall. In one pond, for example, bottom salinity was 6 ppt at low tide and 25 ppt at the following high tide. During extended dry periods, evaporation increases surface salinities in ponds having a small water exchange. More common are salinity variations apparently caused by seasonal changes in groundwater outflow attributable to annual rainfall patterns." (Maciolek & Brock 1974)

Montgomery noted that "(m)any native invertebrate species utilizing brackish water have a pronounced tolerance of salinity instability due to their regular exposure to mixing during changing tides." (Montgomery 2009)

In the *Hawaii Wetland Field Guide* (2006), Dan Polhemus and Ron A Englund authored a Chapter on "Insects in Hawaii's Wetlands." On p. 36 we learn that in brackish Kona pools, the native orange-black damselfly has a distinct advantage over introduced damselflies due to its ability to tolerate waters with salinity in the range of 2 to 8 ppt, and that prior to arrival of the mosquito fish, in the archipelago, this species was probably the dominant damselfly in natural lowland wetlands and in taro patches. (Montgomery 2009)

A related concern is for striped mullet. According to the Smithsonian Marine Station at Fort Pierce, adult striped mullet (*Mugil cephalus)* are highly euryhaline and survive in a range of salinities from 0 ppt. in fresh water, to hypersaline waters with salinity as high as 90 ppt. Naturally-spawned eggs developed to the embryonic stage at salinities between 5 - 60 ppt.
(http://www.sms.si.edu/irlspec/mugil_cephal.htm)

1.1.2.4. Temperature

In viewing Anchialine pond temperature characteristics, 83 percent of the observations lie between 22° and 28° C. The lowest temperature recorded (19° C) was in a narrow fissure (J-44) oriented perpendicular to the shoreline and with a noticeable outflowing current of groundwater. High values seemed to be caused by solar heating abetted by shallowness and a low rate of water exchange. The highest temperature (35° C) was observed twice--at low tide in a pond at Kiholo (F-2) and on a hot, sunny day in a sediment-lined pool (K-3) completely ringed by a mangrove thicket. The salinity of the pool was anomalously high for the area, suggesting strong heating and evaporative processes at work. Most high temperatures were noted at low tide in very shallow water, often overlying black lava. Those extremes probably do not influence the motile fauna (e.g., shrimps) which retreat into the cooler interstitial waters of the lava during low tide and emerge again with the incoming tide. (Maciolek & Brock 1974)

1.1.2.5. Water Quality

In the 1991-96 period (Brock 1997) noted that the concentration of some measured water quality parameters are increasing in the Waikoloa system and attributed these increases to the development (golf courses). These increases were statistically significant but despite this, none of the concentrations approach those measured at undisturbed control sites on the Kona coast.

Furthermore, this study pointed out that up to the present time the aquatic species found in the groundwater and anchialine ponds on the West Hawaii coast appear to be completely insensitive to changes in inorganic nutrient concentrations in the ranges measured in this study. This insensitivity is probably due to these species having evolved in a system where inorganic nutrients are not limiting and thus changes in concentrations in the ranges measured have no impact. Indeed, the study had found that the abundance of *Halocardina rubra* has statistically increased at Waikoloa in 1996 over previous years lending further support that changes in water quality have not negatively impacted the anchialine system. (Brock & Kam 1997)

For over a decade, Brock (1997) searched for pesticides used at Waikoloa on the golf courses and grounds; this search has focused on water, sediment and the tissues of *H. rubra*. Up to this point in time, there has been no evidence of any pesticide contamination in the anchialine ecosystem from any of the development at Waikoloa. (Brock & Kam 1997)

The water quality data suggest that:

(1) coastal groundwater quality at undisturbed sites may be quite variable and in some cases specific nutrient concentrations may be relatively high
(2) changes in coastal groundwater quality may occur with coastal development but the changes seen thus far are within the ranges encountered at undisturbed sites and
(3) unlike most aquatic species, anchialine species appear to be insensitive to the changes water quality in the ranges encountered thus far probably because these species have evolved in a habitat where nutrient concentrations may be quite variable and frequently in excess of biological needs. (Brock & Kam 1997)

In their natural pristine state, both deep ocean water and groundwater violate State water quality standards for nitrogen and phosphorous. (LUC-NELHA 1994)

The National Park's waters are already in violation of the State's water quality standards for nutrients, including nitrates, ammonia, and phosphate, and chlorophyll-a and turbidity. (LUC-TSA 2002)

It is also unlikely that there would be any effects to the nearshore marine environment as a result of increases in nutrient concentrations in groundwater. Dollar and Atkinson (1992) modeled the input of nutrients to the ocean downslope from two golf courses in West Hawaii over a four-year period. Results of the studies showed that at a location where fertilizer nutrients entered an embayment (Keauhou Bay) with restricted circulation relative to open coastal shorelines, nitrates increased by about 100% and phosphate increased by about 20% over natural input (Marine Research Consultants 2002).

However, because the nutrients were retained within a surface layer, there was no exposure to the benthos. Circulation within the embayment was also rapid enough to prevent phytoplankton blooms. These results indicated that even with long-term input of extremely high nutrient subsidies, there are situations where there are no negative effects to the receiving environment. Similar lack of impact would be expected at the Kaloko Honokōhau region where nutrient subsidies would be less than have occurred at Keauhou (Marine Research Consultants 2002).

A concern that has been raised regarding development in the Kaloko-Honokōhau region is the effect to water chemistry at fronting the Park and nearby NELHA. However, neighbors to the north and south of the Park are discharging into trenches and disposal sump, as indicated in the following cases:

- First, NELHA tenants discharge all of their used aquaculture water into on-site trenches.
- Second, since 1993, the primary method for disposal of wastewater effluent from the Kealakehe WWTP has been the use of a temporary sump located in the lava fields just mauka of Queen Ka⍰lahumanu Highway.

The various activities at NELHA utilize warm and cold seawater, and in some instances, brackish groundwater. The majority of these waters are returned to the ocean through gravity seepage from shallow trenches. Evidence of discharge waters has been detected within the groundwater and immediately at the shoreline, but no impacts to the biota have been documented (LUC-NELHA 1994).

The NELHA Comprehensive Environmental Monitoring Program ("CEMP") includes monthly groundwater quality monitoring from 16 wells at six locations and has a major focus of documenting the effects and impacts of these discharges on groundwater, anchialine ponds and the coastal marine waters. Water quality and biota have been monitored regularly under the CEMP program since 1989 and over the course of this period no significant changes have been observed in biotic parameters or water quality. (LUC-NELHA 1994)

1.1.3. Wastewater Treatment and Disposal

Untreated wastewater usually contains concentrations of total nitrogen on the order of 30 to 40 mg/l, and total phosphorus of 4 to 15 mg/l (Nance 2002).

The water discharging into the upper end of Honokōhau Harbor is a mixture of basal groundwater, the County's R-2 effluent discharged into an open pit on the mauka side of Queen Ka⍰lahumanu Highway. The averaged composition of three samples collected in the upper end of the harbor consisted of 20.6 ppt salinity; 45.5 total nitrogen; and 3.08 total phosphorus (Nance 2002).

Based on the inland projection of the harbor and the rate of flow through the basal lens developed by modeling conducted by USGS, the groundwater component of the total discharge into the harbor is likely to be in the range of 1.0 to 2.5 MGD (Nance 2002).

The effluent disposal rate into the pit is about 1.3 MGD. At least half, if not all, of this effluent ultimately discharges into the harbor, meaning that this component of the discharge into the harbor is in the range of 0.5 to 1.0 MGD (Nance 2002).

The quality of the R-2 effluent delivered to the sump is the rounded average of the data: 1.7 ppt salinity; 480 total nitrogen and 115 total phosphorus (Nance 2002).

The Kaloko Makai private WWTP will be designed to reduce the concentrations of the following compounds in the effluent of the Private WWTP to: Total Nitrogen (TN) to a concentration of <5 mg/l, and Total Phosphorous (TP) to a concentration of <2 mg/l.

1.1.4. Minimization through Vadose Zone Natural Attenuation

The vadose zone encompasses the unsaturated sediments that lie between the soil surface and the water table. The physical and hydraulic characteristics of the vadose zone dampen the flux of water and contaminants to the water table. While transiting the vadose zone, contaminants such as fertilizers, pesticides, herbicides and industrial chemicals can be degraded by a process known as natural attenuation.

Natural attenuation processes include a variety of physical, chemical or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentration of contaminants in soil or ground water. These processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation or destruction of contaminants. (Petroleum Hydrocarbons - U.S. EPA Remedial Technology Fact Sheet)

One of the most important components of natural attenuation is biodegradation—the change in form of compounds carried out by living creatures such as microorganisms. Biodegradation processes can be particularly important for natural attenuation of petroleum hydrocarbons, because microorganisms can degrade most environmentally significant petroleum hydrocarbons. (Petroleum Hydrocarbons - U.S. EPA Remedial Technology Fact Sheet)

Hydrocarbons dissolved in water or sorbed on soil particles are the most readily subject to natural attenuation processes Biodegradation is important because many important components of petroleum hydrocarbon contamination can be destroyed by biodegradation, biodegrading microorganisms are found almost everywhere and biodegradation can be very safe and effective. (Petroleum Hydrocarbons - U.S. EPA Remedial Technology Fact Sheet)

The Kaloko Makai WWTP will be designed to produce R-1 recycle water suitable for irrigation within the project boundaries. The treated effluent will be pumped to a R-1 storage tank located on-site and will be used to irrigate parks, school fields, landscaping and other allowed uses for R-1 recycled water.

Supplemental potable water will be added to the R-1 storage tank as needed to ensure that the irrigation demands of the users can be met. During periods of wet weather, excess R-1 water will be disposed of via infiltration basins.

This reuse of treated wastewater is consistent with the Kona CDP that has an action designating the area below Ane Keohokālole as a reclaimed wastewater zone (Action TRAN–3.3a on Figure 4-10c Official Public Facilities and Services Map).

Potential acceptable uses for R-1 recycled water in the Project are listed in Table 1. Note that irrigation of single-family residential parcels is not allowed by DOH.

Table 1. Potential R-1 Recycled Water Uses at Kaloko Makai

Landscape Irrigation	Industrial	Other
• Parks • School yards • Athletic fields • Road sides and medians • Commercial property (if managed by an irrigation supervisor) • Multi-family residential property (if managed by an irrigation supervisor)	• Commercial and public laundries • Industrial cooling • Industrial process water	• Toilet and urinal flushing in buildings with dual water systems • Decorative fountains • Street sweeping • Dust control

Sources of irrigation water for Kaloko Makai will come from recovered R-1 treated wastewater and from the potable system. It is assumed that approximately 15% of applied irrigation water will percolate down to the basal ground water.

As the excess irrigation water percolates downward through the vadose zone to the groundwater, removal rates of nitrogen and phosphorus from the water will be significant.

1.1.5. Conclusions

It is generally accepted that the two large fishponds within the Kaloko-Honokōhau National Historical Park function in a similar manner to smaller anchialine ponds that occur on the west coast of Hawaii. By definition anchialine ponds are surface exposures of the water table with no direct connection to the ocean that contain brackish water which is a mixture of seaward flowing groundwater and landward flowing seawater.

Anchialine ponds in early successional stages usually have sediment-free bottoms that allow for relatively rapid exchange of water. It is important to note that healthy anchialine ponds are NOT nutrient limited systems, and contain high concentrations of plant nutrients. The excess nutrients do not lead to algal dominated water columns, however, as a result of a balance between short residence time of water within the ponds, and production and consumption by pond biota.

Specifically, rapid flux of water through the ponds, and grazing by resident populations prevent plankton buildup within the water column. In the later stages of the anchialine pond cycle, infilling by sediment reduces the rate of water exchange and the balance between production and consumption is lost. Ultimately, in the last stages of pond senescence infilling is complete and ponds become wetlands.

Surveys indicate that Kaloko Pond is not technically an anchialine pond because it contains direct connections to the ocean. Water in the pond is near oceanic in salinity, indicating that groundwater comprises a very small component of the pond makeup. Groundwater flux into the pond is overwhelmed by exchange of ocean water that is driven by wave action carrying water landward through the rock wall. If construction of new rock walls separating the pond from the ocean includes more open channels, it is likely that salinity in the pond will increase even further, lowering the contribution from groundwater.

Aimakapā Pond, on the other hand, can be considered an anchialine pond because it is sealed from direct exchange with the ocean by a sand berm of low permeability. The nearly vertical gradients in salinity between the pond and nearshore ocean provide evidence that the sand berm is essentially impermeable to water exchange (a good analogy is the use of sand bags for flood control levees).

Substantial data also indicates that groundwater flow is predominantly around, rather than through the ponds, and that water is actually flowing landward out of the ponds as a result of offset tidal gradients. These factors combine to result in greatly restricted flow of groundwater into 'Aimakapā Pond.

The restricted flow of freshwater through the ponds is borne out by the near complete lack of both vertical and horizontal gradients within the ponds, as well as substantial damping and lag of tidal oscillations (TNWRE 2002). Thus while the pond consists of water that has salinity less than one half marine waters, the brackish condition is not a result of high input of freshwater, but rather of more restricted exchange with the ocean water than groundwater.

All of factors result in a long residence time within the enclosed basin of 'Aimakapā Pond. Based solely on the volume of 'Aimakapā Pond and the generalized rate of groundwater flow in the area, the residence time of water in the pond is about 30 days.

In reality, owing to the restriction of groundwater flow into the pond, the residence time of water in 'Aimakapā is more likely on the order of 90-120 days.

The metabolic activity within 'Aimakapā Pond can be considered as a simple box model of sources and sinks. The box model clearly indicates that internal cycling between sediments and water within the system is as important in determining metabolic function as fluxes into and out of the system through land, the atmosphere and the ocean.

Measurements of metabolic activity within 'Aimakapā Pond indicate that nutrient uptake is orders of magnitude higher than nutrient supply through groundwater flux. Nutrient cycling between the sediment and water column is by far the predominant process occurring in the pond. Low levels of available inorganic N and P throughout the pond indicate that the nutrient uptake is not presently limited by other factors such as light.

These results are consistent with the physical composition of the system, which consists of a high biomass of phytoplankton in the water column and a sediment floor composed of a flocculent, easily resuspended layer of organic material. As mentioned several times in the sections above, the almost complete lack of physical gradients (temperature, salinity) within the pond indicate very slow turnover of the pond water column by either incoming ocean water or seaward flowing groundwater.

All of these factors indicate that the pond is essentially a closed system that is accumulating sediment that cannot be naturally flushed from the enclosed pond basin. With the warm, sunny year-round climate of the area, high phytoplankton biomass and lack of pond flushing, the pond is an effective positive feedback system.

Continued metabolic activity will produce increasing sediment deposition that will elevate rates of nutrient release from sediment decomposition, which will in turn allow for increased phytoplankton growth. Eventually organic sediment deposition will completely dominate the pond to the point where the water column disappears, and is replaced by a marsh or wetland. Such a progression has been described as the natural "life history" of anchialine ponds.

1.2. Sedimentation and Runoff

A potential mechanism for negative impact to nearshore marine and pond systems is increased sedimentation from wind and surface runoff as a consequence of grading and changes in land use. There appears to be little potential for alteration to the pond and marine communities offshore from increased sedimentation associated with the project for several reasons.

The climate of the Kaloko area is one of the driest in the Hawaiian Islands. On an annual basis, rainfall is likely to be far exceeded by evaporation at the proposed project site. Surface water runoff from storm events is infrequent. The basaltic composition of the land surface is highly porous and is capable of absorbing rainfall with little or no surface runoff. Even in the event of heavy rainfall, the porous nature of the soil ground cover is such that sheet flow carrying suspended sediment toward the ocean would be expected to be relatively small. Rather, most rainwater that would enter the ocean as runoff would do so following percolation through the surface rock layers to the water table, followed by groundwater extrusion at the shoreline.

Mauka lands are presently comprised of extensive areas of exposed soil and rock, with relatively little vegetative groundcover. During the construction phases, it is likely that permit regulations will limit the area of excavation at any particular time, and require dust control measures.

In addition, the predominant direction of wind (land breezes) generated by thermal convection from solar heating of the land mass is inland, resulting in transport of dust inland, and not toward the ocean. As a result, it appears that there is little potential for significant input of sediment to the marine and pond environment resulting from the proposed project.

The entire floors of Kaloko and 'Aimakapā Ponds are covered with a thick layer of fine-grained flocculent sediment. As described above, the sediment layer plays an important role in the metabolic functioning of the ponds. Pond biota are adapted to this high sediment composition. Should a small amount of sediment reach the pond as a result of construction activity, it is not likely that there will be any qualitative change to sediment composition.

Within the marine environment, the nearshore area contains locally high regions of cover of calcareous sands of marine origin. Corals and other reef organisms are capable of removing sediment suspended by natural phenomena, up to threshold levels of deposition where cleaning mechanisms are overwhelmed and organisms become buried.

Because of the existence of natural sands, and the normally turbulent conditions that continually resuspend natural sediment, biotic community structure is presently adapted to extremes in sediment stress from natural conditions.

Organisms that do occur in the region are therefore capable of withstanding the stress associated with large natural sediment loads. In comparison to the frequent natural sediment resuspension within the study area, any additional input from land resulting from construction activity would probably not have the potential to accumulate to the point where organisms could be buried.

1.3. Coral Growth in High Nutrient Water

Nutrient loading and its subsequent impact is one of the more important issues concerning conservation and protection of coral reefs. It is widely believed that any nutrient input to coral reefs is deleterious. The argument is actually based on an incorrect, historical view of how coral reefs recycle nutrients (Atkinson 2003).

Nutrient concentrations were historically observed to change very little across the relatively narrow reef flats (100-300 m) of the Indo-Pacific. Scientists chose to believe that the constancy of nutrient concentrations was the result of rapid recycling through the water column, on scales of several meters (see Hearn, et al., 2001). The notion developed that reefs recycle their nutrients through biologically-mediated mechanisms, and any input of nutrients altered, or perturbed, these processes. Corroborating this view were early results that nutrients, in particular phosphate, affected community metabolism (Kinsey and Davies 1979); and elevated nitrate and ammonia retard coral growth. More recently, nutrient loading appeared to alter the reproductive patterns in corals (Ward and Harrison, 2000; Koop et al., 2001). Furthermore, nutrients actually stimulate the specific growth rate of many macro-algae, so sustained nutrients add to algal growth, with the possible overgrowth of coral. Thus, nutrients were recognized as deleterious. (Atkinson 2003)

However, according to Atkinson (2003), the above conclusion, that nutrients are deleterious to a reef ecosystem, is simply incorrect. The reasoning to question this conclusion is that because of the magnitude of rate constants for mass-transfer limitation of nutrient uptake, nutrients cannot be recycled through the water column on such small scales as a reef flat; it is simply physically impossible. Thus, since the reef can barely take up these nutrients it is very difficult to perturb any biogeochemical cycles or biologically mediated mechanism with relatively small additions of nutrients to the water column. (Atkinson 2003)

Reef communities must also take up very large quantities of nutrients to change the amount of nutrients in the biomass. For example, most "non-significant responses" in the ENCORE experiments were a result of essentially insignificant nutrient loading (Koop et al 2001). Corals must be exposed to very high nutrient concentrations (at least 10 fold above ambient) for many days before there is a negative response in growth (Dubinsky and Jokiel, 1994; Marubini and Atkinson, 1999, Atkinson 2003)

Corals can, and do, grow well at elevated nutrient concentrations, but it is not understood how other biogeochemical compounds influence these rates (Atkinson et al., 1995, Atkinson 2003).Maintaining high concentrations of nitrate or ammonium in water over coral reefs is difficult. Usually, relatively rapid horizontal mixing from currents are much greater that the relatively slow uptake to the bottom. The only significant anthropogenic impacts are in areas of continuous groundwater or surface water discharge onto shallow reefs flats, and where relatively large areas

are impacted by nutrient input (Naim, 1993). In the presence of herbivory, it also has been difficult to show that algae even over-grow corals (Jompa and McCook, 2002), or are deleterious to their growth (McCook, 1999; McCook et al., 2001). (Atkinson 2003)

There are far too many experiments in the literature that just report the concentrations of nutrients in an experiment, instead of the flux of nutrients into the benthic organisms, or the increase of nutrients in internal pools. At present, any careful research on effects of nutrients on coral growth must consider the nature of experimental apparatus and flow characteristics, carbonate chemistry and light. (Atkinson 2003)

Impacts to coral reefs from nutrients are probably indirect and long-term, on an ecosystem scale (Smith and Buddemeier, 1992). Higher nutrient loading probably stimulates net production, creating ever-increasing pools of organic matter and detritus. If not removed from the system by waves and currents, it is plausible that nutrients encourage a bacterial fauna that promotes disease vectors, increasing the susceptibility and spread of disease. Coral diseases must be studied under reasonable nutrient fluxes. Some reefs experience high nutrients, high net production and high transport of organic matter to the shelf (notably fringing reefs of Japan and Western Australia), whereas other reef tracts receiving large amounts of nutrients collect organic matter (Florida Keys). (Atkinson 2003)

Thus, the effects of nutrients must be interpreted on a local scale with respect to local biogeochemical and hydrodynamic budgets; and making sweeping conclusions that all nutrient input is deleterious is simply irresponsible. (Atkinson 2003)

1.3.1. Assessment of Coral Ecosystem Health of Kealakekua Bay and Honokōhau Bay

The following is a summary of an article published in Marine Pollution Bulletin (Parsons 2008). The article reports results of a study that compared the coral ecosystem "health" at four coral dominated marine sites within two embayments on the lee side of the island of Hawai'i (Kealakekua and Honokōhau Bays) for the purpose of identifying impacts from anthropogenic impacts to these relatively pristine areas.

1.3.1.1. Study sites

Two locations were chosen for this study; Honokōhau Bay and Kealakekua Bay on the central, leeward coast of the island of Hawai'i. Honokōhau Bay was chosen because of its extensive coral growth (Cochran et al., 2006) coupled with concerns of ongoing and future development in its watershed (Greene, 1993) (see Figure 2).

A small boat harbor (Honokōhau Harbor) was built in the bay in 1970 and expanded in 1978 (USCOE, 1983), substantially increasing the amount of ocean activities in and around the bay. The harbor was constructed in a nonconventional way, in which it was excavated from porous basaltic rock landward of the shoreline (Maragos, 1991). This landward excavation caused much of the natural groundwater flow to now discharge through the harbor walls and floor, thereby focusing the flow of groundwater out of the harbor mouth and into the nearshore coastal waters (Gallagher, 1980). Therefore, while the landward excavation of the harbor may have minimized impacts to the

adjacent reefs in Honokōhau Bay, the concentrated groundwater discharge out of the harbor mouth may have created a more chronic stressor.

West Hawai'i discharges approximately 1.35 million gallons per day (mgd) of their treated sewage water from the Kealakehe Waste Water Treatment Plant into the vicinity of Honokōhau Harbor, and the projected capacity for the plant is 5.31 mgd (while not noted by Parsons et al., 2008, for approximately the last decade, all of the treated effluent from the Kealakehe WWTP has been discharged into a shallow lava sinkhole directly upslope from Honokōhau Harbor).

Kealakekua Bay was chosen for several reasons: (1) there are some baseline data from the past (e.g., Doty, 1968); (2) developers have built residential units and golf courses in the area (e.g., the Hōkūli'a development); and (3) Kealakekua Bay is a Marine Life Conservation District (MLCD), with a well-developed reef and extensive coral cover, and is therefore visited by many tourists. Resource managers are concerned about possible detrimental impacts that tourists are having on the coral ecosystems in Kealakekua Bay (and other MLCD; Holland and Meyer, 2003).

As with Honokōhau, there is substantial ground water influx into Kealakekua Bay from four distinct discharge points, two from the north-side of the bay, and two along the south-side (Doty, 1968).

1.3.1.2. Sampling design

Four permanent 50 m transect lines were established within each bay along an approximate 10 m isobath, two to the north and two to the south (see Figure 3). Of the two lines (north and south in each bay), one was established oceanward, the other landward in each bay. The purpose of such transect line placement was to determine if one side of the bay displayed more evidence of nutrient loading and subsequent impacts due to differences to wave exposure (more wave action expected on the southern lines; Dollar, 1982), and if the land lines displayed more evidence of nutrient loading and subsequent impacts due to the closer proximity of terrestrial inputs of nutrients.

Figure 2 Location of Study Sites, Honokōhau and Kealakekua Bays

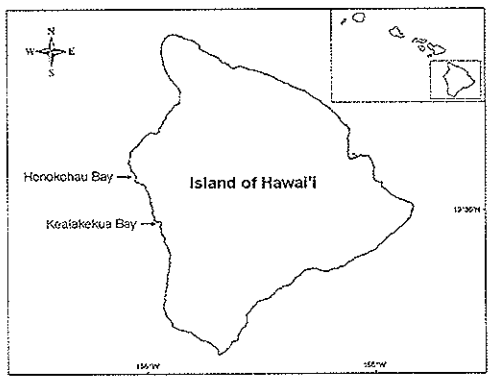
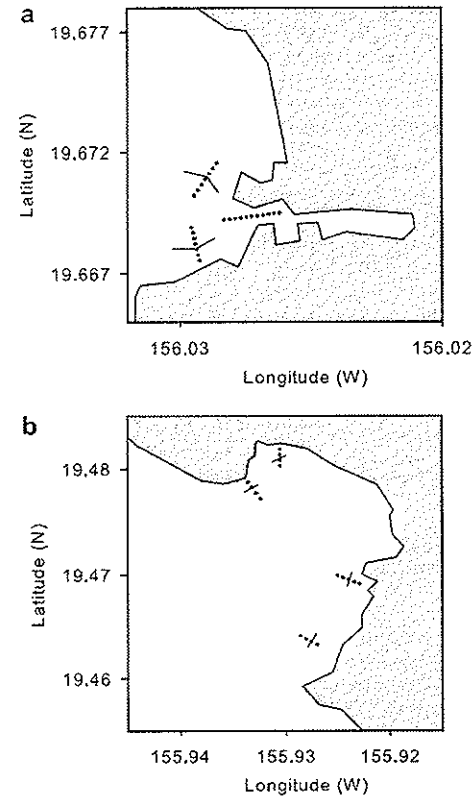


Figure 3 Sampling Design



The four lines in Kealakekua Bay were located near the four-groundwater discharge points, whereas the four lines in Honokōhau Bay were situated outside the mouth of the harbor, where much of the groundwater discharges into the bay. Three 5 m x 5 m squares were randomly selected for sampling along each transect line using a random number generator. Water samples were collected over a 15-month period (June 2004–August 2005) at all sampling squares.

1.3.2. Results

Salinity was lowest on the Honokōhau south lines and highest on the north inside and south outside lines at Kealakekua Bay. Average temperatures were slightly higher in Kealakekua Bay.

The highest nitrate + nitrite concentrations were measured on the north outside line of Kealakekua Bay, while the lowest concentrations were from the south inside line in Kealakekua Bay. It should be noted however that the average value of nitrate + nitrite measured at five of the eight sampling locations was below the State of Hawaii Water Quality Geometric mean standard for open coastal waters (0.36 µM).

Of the three locations where the average value was above the geometric mean standard, the maximum of 0.45 µM was only slightly above the standards. The Kealakekua Bay sites tended to have higher concentrations of silicate and ammonium than the Honokōhau sites. $\delta^{15}N$ values averaged <3 parts per trillion (ppt) for all sites, indicating an atmospheric source of nitrogen, likely to be either anthropogenic fertilizer or natural nitrogen-fixing processes (Costanzo et al., 2001). $\delta^{15}N$ values were highest along the Kealakekua Bay north outer line and lowest on the Honokōhau north outer.

Water column pheophytin concentrations were highest at the south inside line in Kealakekua Bay and lower elsewhere. Phosphate, TDN (Total Dissolved Nitrogen) and chlorophyll-a concentrations were consistent among the squares.

There were some differences in benthic composition across the eight sites. The highest abundance of healthy coral was present at the north inside line in Kealakekua Bay, the least in the south inside line in Kealakekua Bay and both the north and south outside lines in Honokōhau Bay.

The highest percentage of stressed coral was seen at the south inside line in Kealakekua Bay. The most dead coral was seen at the north outside line in Kealakekua Bay, the least at the north outside line in Honokōhau Bay, which also displayed the highest abundance of octocorals (*Anthelia edmondsoni*). In fact, octocorals were found at all of the Honokōhau Bay sites, but only at one site in Kealakekua Bay (north inside).

Thus, results of this study showed that the lowest amount of healthy coral and the most stressed coral occurred in Kealakekua Bay, which is clearly less impacted by human activity than Honokōhau Bay that receives direct discharge of groundwater directly affected by input of sewage effluent.

The highest percentage of coralline algae was seen on the north outside line in Kealakekua Bay, whereas the most fleshy algae was present at the south outside line in Kealakekua Bay. The south inside line in Kealakekua Bay had the highest percentage of turf algae; the south inside line at Honokōhau Bay had the lowest. Coral diversity was highest on the north inside line at Kealakekua Bay, as was coral species richness. Coral diversity was lowest on the south inside line in Kealakekua Bay, and coral species richness was lowest on the north inside and south outside lines in Honokōhau Bay, and the south outside line in Kealakekua Bay. Cyanophyte cover did not vary between sites.

Many of the biotic variables exhibited statistically significant relationships with the abiotic variables. For example, two of the four algal groups (coralline and fleshy algae) exhibited positive relationships with nitrate + nitrite, ammonium, and/or silicate.

As Kealakekua Bay had the highest cover of algae, and there is a positive correlation between algae and nitrate + nitrite, it is apparent that the discharge of sewage effluent nutrient in Honokōhau is not exerting a significant effect on algal abundance.

Dead coral abundance was positively related to nitrate + nitrite, ammonium, silicate and $\delta^{15}N$, indicating that more dead coral was present where nutrient concentrations (and $\delta^{15}N$) were higher. Conversely, there also was a positive relationship between nitrate + nitrite and % healthy coral cover. There was a positive relationship between healthy coral cover and phosphate concentrations as well. Stressed coral % cover was higher when TDN was higher.

Such positive correlations suggest that either nutrients have a positive effect on coral growth, or other factors not related to nutrients are responsible for higher cover in areas where nutrient concentrations are also elevated.

Correlations among the biotic factors demonstrate that a negative relationship between coral and algal cover exists. For example, there is a negative relationship between turf abundance and healthy coral cover.

This relationship is likely a response to turf growing in areas that are too physically harsh for corals to grow. Additionally, there is a positive relationship between both the abundance of coralline and fleshy algae with dead coral cover. Octocoral abundance, on the other hand, was negatively related to dead coral abundance, but positively correlated with stressed coral abundance.

Based on the above results, 11 parameters (silicate, ammonium, TDN, $\delta^{15}N$, cyanophyte abundance, coralline algae abundance, turf algae abundance, fleshy algae abundance, healthy coral abundance, dead coral abundance, and stressed coral abundance) were chosen as coral reef health indicators and were given impact scores according to the parameter rankings across the 24 squares (1 = lowest impact ranking; 24 = highest impact ranking).

Nitrate + nitrite was not used as it displayed positive (conflicting) results with both dead and healthy coral cover (see above). High values of cyanophyte cover, coralline algae cover, fleshy algae cover, turf algal cover, silicate, ammonium, TDN, and $\delta^{15}N$ were considered to be evidence of high impact, according to positive relationships between the nutrient variables and algal parameters, negative relationships between nutrient variables and coral health, or negative relationships between algal parameters and coral parameters.

Healthy coral cover was evidence of low impact, whereas stressed and dead coral cover were considered to be evidence of high impact. Octocoral cover and phosphate were considered positive factors as octocoral abundance was negatively correlated with nutrient parameters and dead coral cover, whereas phosphate was positively correlated with % healthy coral abundance.

Salinity and temperature were not included because potential anthropogenic influence to these parameters (i.e., groundwater manipulation) is impossible to assess at this juncture. Each parameter was ranked across the squares, and the rankings of all the parameters were averaged by square. The two-way ANOVA (Analysis of Variance) did not find any differences between the north versus south lines ($F_{1,21} = 0.17$; $p = 0.6854$) nor inside versus outside lines ($F_{1,21} = 0.82$; $p = 0.3764$) across the bays.

One-way ANOVA results indicated that there was a significant difference in the impact scores between bays ($F_{1,22} = 21.17$; $p = 0.0001$), in which Kealakekua Bay had a higher average impact score than Honokōhau Bay.

The Kealakekua north outside line had the highest impact score, whereas the two north lines in Honokōhau Bay had the lowest scores.

It should be noted that these results did not vary significantly if octocorals were treated as a negative factor (due to their correlation with stressed coral), nor if phosphate were treated as a negative factor (being a nutrient), nor if nitrate + nitrite ranking were included in any capacity (positive or negative); KNO always had the highest impact score and HNI and HNO always had the lowest scores.

A comparison of the historical and present-day nutrient data indicate that the groundwater entering Kealakekua Bay and Honokōhau Harbor are now more enriched in nitrate + nitrite and phosphate versus the past. Regression analysis results statistically support this observation.

A comparison of the slope and intercept confidence intervals indicates that the groundwater entering Honokōhau Harbor has twice as much nitrate + nitrite and five times as much phosphate versus two decades earlier. The differences in the nutrient data analysis results between this study and OI Consultants (1991) indicate that the nutrient enrichment present today has occurred since 1991 and therefore after the harbor expansion in 1978.

Nitrate + nitrite concentrations are approximately six times higher in groundwater entering Kealakekua Bay, although phosphate concentrations may not have changed as the confidence intervals from the two time periods overlap, indicating that there is no significant differences in slopes or intercepts between Doty (1968) and this study.

With the exception of phosphate in Kealakekua Bay, however, it is evident that groundwater is more enriched in nutrients in Honokōhau Harbor and Kealakekua Bay now versus past decades.

Discussion

The most impacted site of this study (Kealakekua Bay North Outside (KNO)) had the highest cover of dead coral and coralline algae and the highest values of nitrate + nitrite, silicate, and $\delta^{15}N$. The latter nutrient results indicate that a stronger terrestrial signal may be present at KNO, although an expected lower salinity signal was not evident. The lack of a signal could be due to strong mixing processes, as the water column was well-mixed 36.8% of the time at KNO over the course of the study, a higher frequency than the other sites. As the salinity signal of groundwater discharges

attenuates rapidly in many coastal environments, other tracers of groundwater discharge are being developed and utilized, including radium measurements (Paytan et al., 2006).

Although four out of the five highest impact scores are from Kealakekua Bay sites, the groundwater discharges into Honokōhau Harbor have increased to higher concentrations than Kealakekua Bay.

The Honokōhau sites do not have higher impact scores because it could be that the harbor signal is attenuated before the groundwater discharges can influence the four Honokōhau Bay sites. The attenuation could be due to mixing processes diluting the groundwater inputs in the lower nutrient ocean waters, or conversely to the lack of mixing, as a significant proportion of the groundwater exiting Honokōhau Harbor is in a buoyant surface plume that does not likely mix effectively through the water column (Gallagher, 1980; Dollar and Atkinson, 1992).

The water column was well-mixed in Honokōhau Bay 3.6–16.9% of the time, indicating that a stable water column was more frequent (83.1–96.4% of the time). The groundwater fluxes could be higher in Kealakekua Bay, although further studies (e.g., radium measurements) would be needed to test this possibility.

The groundwater now entering Honokōhau Harbor are more enriched with nitrate + nitrite and phosphate than in the past.

One possibility for the two northern sites in Kealakekua Bay exhibiting most signs of impact is that the northern sites are sheltered and therefore exposed to less wave action than any of the other sites. This may be true for KNI, which had a stable water column over the entire course of the study, but the water column at KNO was well-mixed 36.8% of the time.

Previous studies have demonstrated that wave-exposed areas tend to display lower levels of degradation and recover more quickly from acute events (i.e., storms; Connell et al., 1997). Sheltered areas tend to have lower flushing rates, resulting in higher residence times of overlying waters. Doty (1968) observed high water retention times in the vicinity of KNO and KNI due to the back-and-forth motion of the tidally influenced current, which could further exacerbate poor flushing along the sheltered north shore of the bay.

All of the reef sites were exposed to waters with salinity lower than ambient open ocean conditions, suggesting that exposure to waters with elevated nutrient concentrations may be a frequent occurrence. For example, water with a salinity of 32.6 ppt in Kealakekua Bay (the minimum salinity recorded at KNI) would have nitrate + nitrite concentrations at least six times higher than ambient ocean conditions and phosphate concentrations at least 10 times higher.

Oceanic waters with salinities 5–10% lower than ambient ocean waters can contain 5–10 times more nutrients (assuming conservative mixing). The coral sites examined in this study were exposed to such salinities 8–25% of the time, demonstrating that sporadic exposure to such enriched waters may be a stressor that needs to be better monitored and accounted for.

While there is evidence of nutrient and algal-borne stress, the health of the sites of this study are comparable to other Hawaiian sites. Coral cover reported here (approximately 36–62%) is similar to

that reported in other studies (Dollar, 1982), and are higher than the average cover reported for the main Hawaiian Islands (22%; Jokiel et al., 2004). Coral diversity is similar to that reported by Dollar (1982) and was not significantly related to abiotic parameters (except salinity), a finding also reported by Brown et al. (2004). The dominance of Porites species (data not shown; averaging approximately 90% of all corals) indicates that the coral ecosystems of this study are near climax stage (Grigg and Maragos, 1974).

Storm wave action is the primary factor determining coral cover and diversity (Dollar, 1982). It has been estimated that it takes a coral ecosystem in Hawai'i 50 years to recover (and reach a climax community) from an acute disturbance (Grigg and Maragos, 1974). As the interval between severe storms affecting a given coral ecosystem is 40 years on average (Dollar, 1982), a pristine (or low-impacted) coral ecosystem already has a tight window within which to fully recover from such events. As chronic disturbances have been shown to hinder recovery (Connell et al., 1997; Hughes and Connell, 1999), it is possible that (some) coral ecosystems may not (fully) recover from the next severe storm.

Coral ecosystems will not normally recover from chronic stresses until the stressors are removed (Grigg, 1995; Edinger et al., 1998). If elevated nutrients and/or algal cover are chronic stressors to the coral ecosystems of this study as the results indicate, and future human population growth and development continue to increase nutrient inputs to these bays, then it is likely that future degradation is imminent, especially at the northern sites of Kealakekua Bay.

1.4. Endangered Marine Species

Several species of marine animals that occur in Hawaiian waters have been declared threatened or endangered by Federal jurisdiction. The threatened green sea turtle *(Chelonia mydas)* occurs commonly along the Kona Coast, and turtles are frequently observed on beaches throughout the area.

The endangered hawksbill turtle *(Eretmochelys imbricata)* is known infrequently from waters off the Kona Coast.

Populations of the endangered humpback whale *(Megaptera novaeangliae)* are known to winter in the Hawaiian Islands from December to April.

The Hawaiian Monk Seal, *(Monachus schauinslandi)*, is an endangered earless seal that is endemic to the waters off of the Hawaiian Islands. Monk seals commonly haul out of the water onto sandy beaches to rest.

There are several protected marine species that may inhabit the offshore environment. Because there is no plan for any work in the nearshore region, there is no potential for blasting or excavation that might affect behavior of whales, monk seals and other marine mammals. Similarly, there is little potential for changes in water quality resulting from construction.

As part of the Kaloko area mauka of Queen Ka'ahumanu Highway is a National Park, Kaloko Makai will not alter access to the shoreline. Thus, there is little potential for any negative factors associated with the project that may affect turtles, whales, seals or other protected species.

1.5. Water Quality Standards

Pursuant to Hawai'i Administrative Rules (HAR) Title 11, Chapter 54, Water Quality Standards, the Department of Health (DOH) classifies various water uses. Inland waters are classified under two use classes, 1 and 2; marine waters are classified under two use classes, AA and A (see Figures 4 and 5).

As a point of reference, DOH objective of class "A" waters is that their use for recreational purposes and aesthetic enjoyment be protected.

Along the Kona coast, and essentially around most of the island of Hawai'i (from Kawaihae heading south around South Point up to Leleiwi Point near Keaukaha,) DOH has classified the nearshore waters as "AA."

It is the objective of class AA waters that these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions.

To the extent practicable, the wilderness character of these areas shall be protected. The uses to be protected in class AA waters are oceanographic research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation, and aesthetic enjoyment.

According to DOH rules, the classification of any water area as Class AA shall not preclude other uses of the waters compatible with objectives and in conformance with the criteria in the rules.

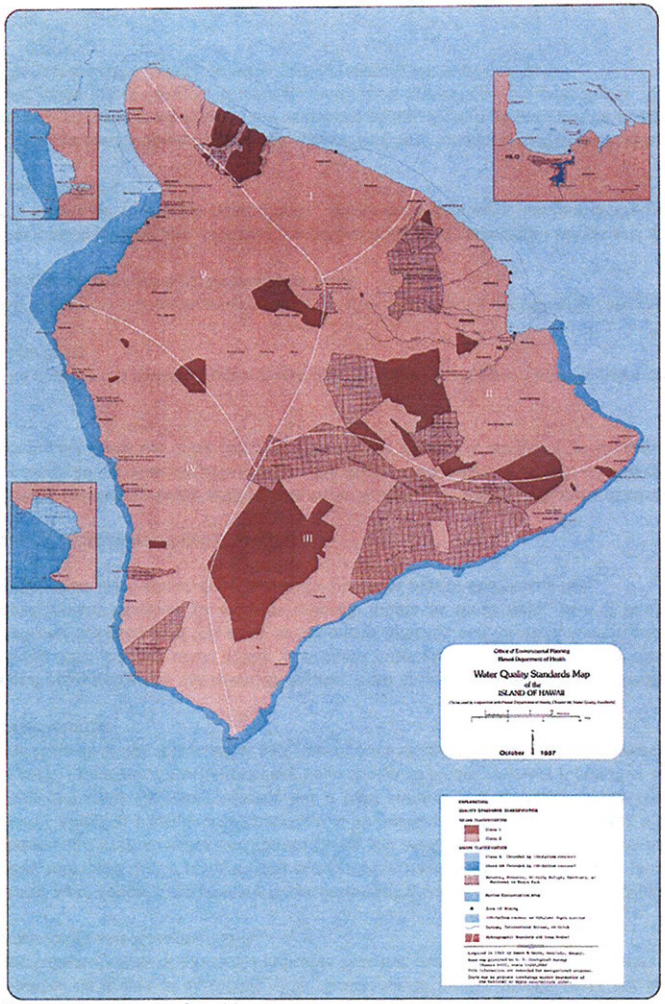
Note that the coastal area below the Kaloko Makai project is classified both class "A" and "AA", as shown in Figure 3-15 and 3-16.

Storm water discharge into State waters is allowed provided it meets the requirements and the basic water quality criteria specified in the DOH rules.

In their natural pristine state, both deep ocean water and groundwater violate State water quality standards for nitrogen and phosphorous (LUC-NELHA 1994).

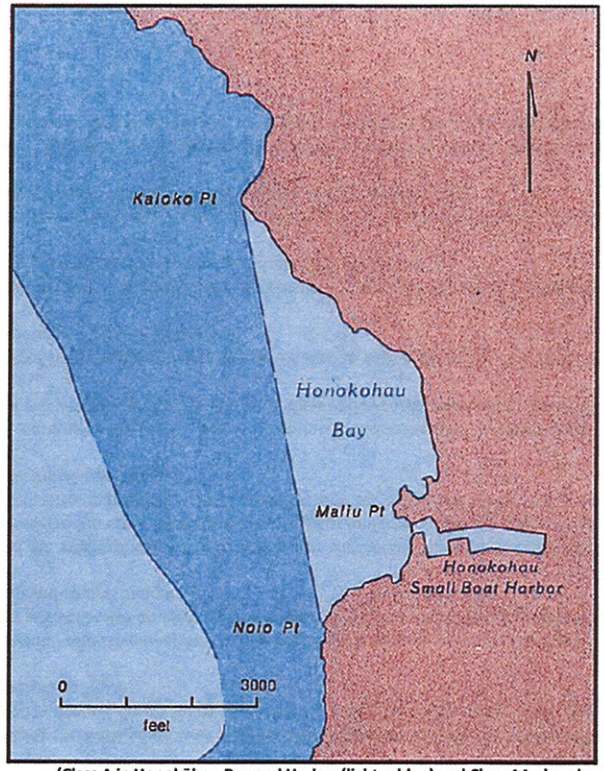
The National Park's waters are already in violation of the State's water quality standards for nutrients, including nitrates, ammonia, and phosphate, and chlorophyll-a and turbidity (LUC-TSA 2002).

Figure 4 Water Quality Standards Map, Island of Hawaii



Source: Department of Health

Figure 5 Honokōhau Bay, Class A Waters



(Class A in Honokōhau Bay and Harbor (lighter blue) and Class AA elsewhere (darker blue))

The Kaloko-Honokōhau National Historical Park, located makai of the project site along the coast and separated from the project site by Queen Kaahumanu Highway, contains two principal fishponds, the Kaloko and ʻAimakapā fishponds, several anchialine ponds and associated wetlands.

The anchialine ponds located within the Kaloko-Honokōhau National Historical Park lack a surface connection to the ocean, but are hydrologically connected to ground water and the ocean by a permeable aquifer.

1.6. Potential Impacts and Mitigation Measures

Ponds: The potential for impact to marine and pond communities as a result of development appears to be minimal. The two large fishponds within the Park are similar, with thick layers of sediment lining the floors of the ponds.

Kaloko Pond is separated from the ocean by a man-made rock wall that contains openings to promote exchange of pond water and ocean water. 'Aimakapā Pond is sealed from the ocean by an unbroken sand berm. The distinct discontinuities between concentrations of water chemistry constituents between the seaward end of the 'Aimakapā Pond and the nearshore portion of the ocean indicate that the sand berm is an effective barrier preventing free exchange between the pond and ocean.

Both ponds exhibit little vertical and horizontal stratification. The lack of stratification, along with substantially damped tidal oscillations in both magnitude and time, indicate a substantially reduced input of groundwater relative to what would if there was free exchange between the ponds and groundwater flow. The tidal damping also results in landward flow of water out of the ponds during periods when pond levels are higher than groundwater in surrounding lava formations, and flow into the pond when pond levels are lower than in surrounding rock.

Concentrations of inorganic nutrients, particularly NO_3^- and PO_4^{3-}, which are high in basal groundwater, are substantially lower in the ponds. Measurements of metabolism within 'Aimakapā Pond indicate high rates of both gross production and respiration.

Even with no consideration of the limited input of groundwater to the ponds, the maximum amount of metabolism that can be attributed to groundwater nutrients is under 5%. Therefore, a minimum of 95% of pond metabolism is driven by nutrients recycled within the pond. Such a scenario is consistent with the lack of stratification within the ponds, high phytoplankton biomass and thick flocculent organic sediment that lines the floor of the pond.

In addition, it has been repeatedly documented that healthy anchialine ponds are not nutrient limited, so increases in nutrient concentrations will no effect as long as the physical and biological components of the ponds are kept intact. Because 'Aimakapā Pond potentially utilizes groundwater nutrients for only a small percentage of metabolic requirements, the small changes to groundwater composition that may occur from changes in upland land uses will not result in detectable differences in pond function.

Estimates of cumulative changes to groundwater from the total assemblage of existing and proposed projects also do not appear to have the potential for alterations to pond or marine habitats. Future developments will be required to utilize the County wastewater treatment plants, hence eliminating the major source of nutrient subsidies.

With suspect to NELHA, cold water used by the mariculture facilities is pumped from below the mixed layer, and does not come into contact with surface ocean water. In addition, high nutrient water used at the facility is discharged into trenches that allow percolation to the coastal ocean. As a result, nutrient concentrations in groundwater that flows to the ocean is presently higher at NELHA than it could be with construction and operation of the planned project.

Examination of other similar fishponds that receive groundwater input and are separated from the ocean by sand berms indicates no apparent effects from surrounding development. 'Aimakapā Pond is functioning essentially as a closed system in a positive feedback mode.

Physical attributes of 'Aimakapā pond restrict groundwater input, while high organic deposition and decomposition supply an ample source of nutrients to support high production within the water column. With no flushing, organic buildup will continue and the cycling process will accelerate until the pond is transformed into a wetland. The most likely action to interrupt this feedback system may be to conduct a sediment removal process (e.g. dredging) that would curtail the nutrient cycling-organic deposition that is currently taking place.

Potential water quality impacts during construction of the project will be mitigated by adherence to State (HAR Chapters 11-54 and 11-55, as applicable) and County water quality regulations governing grading, excavation and stockpiling. The County's grading ordinance includes provisions related to reducing and minimizing the discharge of pollutants associated with soil disturbing activities in grading, grubbing and stockpiling.

Construction Best Management Practices (BMPs) will be utilized in compliance with County ordinances pertaining to grading, grubbing, stockpiling, soil erosion and sedimentation during construction. BMPs will also be implemented for long term development and operation of activities occurring on the site as part of pollution prevention measures.

BMPs are measures, controls, and devices used to prevent pollution from being discharged into waters such as rainwater and surface water and then carried into streams, ponds and oceans (LUC-TSA-2002).

BMPs include storm water runoff and non-storm water sources control measures and practices that will be implemented to minimize the discharge of erosion and other pollutants from entering into the receiving State waters. The erosion control plan for the proposed project include temporary and permanent control measures BMPs that will be implemented in accordance with Chapter 10 of the Hawai'i County Code.

Post construction BMPs to prevent erosion and storm water runoff after construction is completed includes the installation of drain inlets and shallow drywells within the project site, and landscaping and grassing of disturbed areas.

Prior to the occupancy of any residential or commercial unit within the Project, Kaloko Makai will implement and maintain storm and surface-water runoff best management practices, subject to any applicable review and approval of the State of Hawaii Department of Health ("DOH,") designed to prevent violations of State water quality standards as a result of storm-water discharges originating from the Project.

Kaloko Makai will develop a pollution prevention plan ("PPP") that provides Best Management Practices ("BMPs"), including structural BMPs, for pollution prevention that address all categories of permitted uses within the project, and will address environmental stewardship and the non-point sources of water pollution that can be generated from any uses allowed within

the Project. Emphasis shall be given to BMPs that prevent or limit pollutants arising out of the permitted uses within the Project from reaching the groundwater and ocean.

Control of contaminated surface water can be achieved through the development of a Pollution Prevention Plan ("PPP") designed to address all pollutants associated with industrial development and to identify measures that will contain and treat such pollutants in order to prevent any release into the environment, including the groundwater. (LUC-TSA 2002)

Kaloko Makai will construct and operate a Private Wastewater Treatment Plant (WWTP) within the project. The WWTP will be designed to reduce the concentrations of the following compounds in the effluent of the Private WWTP to: Total Nitrogen ("TN") to a concentration of <5 mg/l, and Total Phosphorous ("TP") to a concentration of <2 mg/l (aerobic nitrification processes combined with anoxic/anaerobic sand filters to perform denitrification, or comparable technology.)

Installation of the Private WWTP shall be subject to conditions of approval by the DOH, including any lower concentrations of TN and/or TP in the effluent, and HAR Chapter 11-62.

An on-site wastewater treatment plant will be self-sufficient, water efficient and environmentally sound. The Kaloko Makai facility will treat the wastewater to provide recycled (R-1) water for general irrigation within Kaloko Makai and thus lessen demand for potable water for irrigation needs.

This reuse of treated wastewater is consistent with the Kona CDP which has an action designating the area below Ane Keohokālole as a reclaimed wastewater zone (Action TRAN–3.3a: Designates the reclaimed wastewater zone (Wastewater Re-use Area) on Figure 4-10c Official Public Facilities and Services Map.)

Kaloko Makai shall refrain from allowing the occupancy of any residential or commercial unit within the Project until such time as the respective unit to be occupied is connected to either: (i) a private wastewater treatment plant and effluent disposal system serving the Project (Private WWTP); (ii) the Kealakehe Wastewater Treatment Plant (Kealakehe WWTP); or (iii) a public wastewater treatment plant other than the Kealakehe WWTP (Public WWTP), provided, however, that Kaloko Makai's obligation to connect to Kealakehe WWTP shall terminate upon the County Council's approval of the Change of Zone (COZ).

1. Kealakehe WWTP. If the connection to the Kealakehe WWTP is accessible to the Project prior to the County Council's approval of the COZ, Kaloko Makai shall develop the Project with sewer lines to be used to connect the Project to the Kealakehe WWTP. In addition, if the connection to the Kealakehe WWTP is accessible to the Project prior to the County Council's approval of the COZ, Kaloko Makai shall collaborate with the County of Hawaii to include the Project within an improvement district, if one is developed, to fund the connection to the Kealakehe WWTP, or to have incorporated as a condition of approval to the COZ, the requirement that the Project pay, at the time of full funding for such improvements, its fair share of the cost to fund such connection to the Kealakehe WWTP, whether or not an improvement district is established.

2. Private WWTP. If the connection to the Kealakehe WWTP is not accessible to the Project prior to approval of the COZ and no connection to a Public WWTP acceptable to Kaloko Makai is available prior to the completion of construction of the Private WWTP, Kaloko Makai, at its sole discretion, shall develop the Project to be served by a Private WWTP. The Private WWTP shall be designed to reduce the concentrations of the following compounds in the effluent of the Private WWTP to: Total Nitrogen (TN) to a concentration of <5 mg/l, and Total Phosphorous (TP) to a concentration of <2 mg/l (aerobic nitrification processes combined with anoxic/anaerobic sand filters to perform denitrification, or comparable technology). Installation of the Private WWTP shall be subject to conditions of approval by the DOH, including any lower concentrations of TN and/or TP in the effluent, and HAR Chapter 11-62.

    a. Effluent disposal for the Private WWTP shall be in accordance with all applicable laws and shall be subject to any approvals required by the DOH and/or the Planning Commission.

    b. Monitoring of the Private WWTP will be pursuant to the annual reporting requirements of the DOH, Wastewater Branch, and shall include a monthly summary of concentrations of TN and TP in the effluent, the volume of recycled water used, the volume of recycled water stored, the volume and location of any recycled water spills, volume of any reject wastewater, and details on the irrigated areas including water budgets, precipitation, evaporation, application rates and monitoring of best management practices.

Kaloko Makai will develop a groundwater monitoring plan, to detect contaminants in the groundwater below the Project. Groundwater monitoring wells will include one (1) well hydrologically up gradient from the developed areas within the Project, located and drilled to a depth that is appropriate and sufficient to yield samples that are representative of background water quality and not affected by the Project and two (2) wells hydrologically down gradient from the developed areas within the Project, located and drilled to depths sufficient to provide early detection of any organic or inorganic chemicals migrating from the Project into the groundwater underlying the Property.

The groundwater-monitoring plan, will be comprised of the elements listed below under Section "Monitoring Wells" and Section "Sampling and Analysis Plan" (collectively, the GWM Plan) to detect contaminants in the groundwater below the Project. Kaloko Makai shall submit in electronic format copies of all data, reports and analysis gathered pursuant to GWM Plan to the NPS.

1. Monitoring Wells. Kaloko Makai shall monitor groundwater through the wells described below:

    a. One (1) well hydrologically up gradient from the developed areas within the Project, located and drilled to a depth that is appropriate and sufficient to yield samples that are representative of background water quality and not affected by the Project.

b. Two (2) wells hydrologically down gradient from the developed areas within the Project located and drilled to depths sufficient to provide early detection of any organic or inorganic chemicals migrating from the Project into the groundwater underlying the Property.

c. All monitoring wells shall be designed and constructed in accordance with State of Hawaii specifications and shall be permitted pursuant to the laws of the State of Hawaii.

2. Sampling and Analysis Plan. Kaloko Makai shall develop and follow a Sampling and Analysis Plan that includes protocols and techniques for sample collection, sample preservation and shipment and analytical procedures. The sampling frequency shall begin at least six (6) months prior to the start Grading Activity, and shall be conducted quarterly for two (2) years after the start of Grading Activity, and annually thereafter or as required by the Planning Commission or the DOH.

   a. Parameters to be analyzed shall include pH, temperature, salinity, nitrate, ammonia, dissolved organic nitrogen, TDS, TN, phosphate, dissolved organic phosphorus and TP and any other parameters required to be monitored by the Planning Commission or the DOH.

   b. The Sampling and Analysis Plan shall include a Quality Assurance Project Plan (QAPP) with specific quality control performance criteria for precision and bias and chain of custody procedures (the QAPP). The QAPP shall include method detection limits that are at least an order of magnitude lower than ambient groundwater concentrations for all nutrients.

3. GWM Plan Approval

   a. At least one hundred twenty (120) days prior to the start of Grading Activity within the Project, Kaloko Makai shall submit the GWM Plan to the Director of the County of Hawai'i Planning Department (the "Planning Director") for review and approval, contingent upon the Planning Director's acceptance of such an approval role (the "County of Hawai'i Planning Department Approval"). At least sixty (60) days prior to submitting the GWM Plan to the Planning Director, Kaloko Makai shall provide a draft GWM Plan to NPS for review and comment. NPS shall provide comments and/or requests for changes to the GWM Plan within thirty (30) days of receipt. To the extent that Kaloko Makai does not accept NPS's comments or changes. Kaloko Makai shall provide such NPS comments and changes to the Planning Director at the time it submits the GWM Plan for Planning Director Approval.

   b. In no event shall Kaloko Makai start Grading Activity on the Property until the GWM Plan is approved by the Planning Director, the Planning Commission or the DOH, as applicable.

   c. Kaloko Makai shall implement the approved GWM Plan.

1.7. Evidence of Impacts - Nearby Development Communities

Several neighboring developments north of the Kaloko Makai project have several similar (and some unique) characteristics as the Kaloko Makai proposal:

- groundwater wells uphill from the project for water source
- private wastewater treatment facilities and
- variety of land uses (residential and commercial)

A significant difference is Kaloko Makai does not have resort or golf course uses. Another significant dissimilar characteristic is that all of the others are oceanfront projects; Kaloko Makai is not.

The following summaries highlight the fishpond and anchialine pond characteristics, as well as other nearshore water quality issues. As you can see in the following, up-gradient groundwater wells, surface water run-off, and private wastewater treatment and disposal systems do not appear to have negative impacts on these matters.

Hualālai Resort

Hualālai Resort on the Big Island of Hawai□i is a master-planned residential resort community on 865 acres along the Kona-Kohala Coast. The property offers over one-half mile of white sandy beach and includes a mix of single-family homes, villas and lots. Featured amenities include two golf courses, an 18-hole Jack Nicklaus Signature golf course and, an 18-hole Tom Weiskopf-designed golf course.

Following is a summary of the wells serving the Resort:

Hualālai Well Name	Casing Dia. (in.)	Ground Elev. (ft.)	Well Depth (ft.)	Use Cat.	Yr. Drill	Use Yr.	Init. Head (ft.)	Pump Capacity (gpm)	Average Pumpage (MGD)	High Avg. Pumpage (MGD)
Hualālai Salt 4	12	5	40	OTH	1995	96		1100		
Beach Pool	6	3	8	OTH	1996	96	0.3	150		
Fitness Center	6	13	26	OTH	1996	96		100		
Hualālai Makai	10	250	270	UNU	1994	94	1.6			
Hualālai Salt 1	12	3	40	OTH	1995	96		1100		
Hualālai Salt 2	12	3	40	OTH	1995	96		1100		
Hualālai Salt 3	12	4	80	OTH	1995	96		1100		
Ka□□pūlehu	12	934	985	IRR	2001	01	5.39	590	0.60	0.81
Ka□□pūlehuPot 3	16	1321	1421	MUN	1999	99	5.8	450	0.30	0.56
Main Pool	6	4	11	OTH	1996	96	1	90		
Palm Grove	6	3	9	OTH	1996	96	1.1	60		

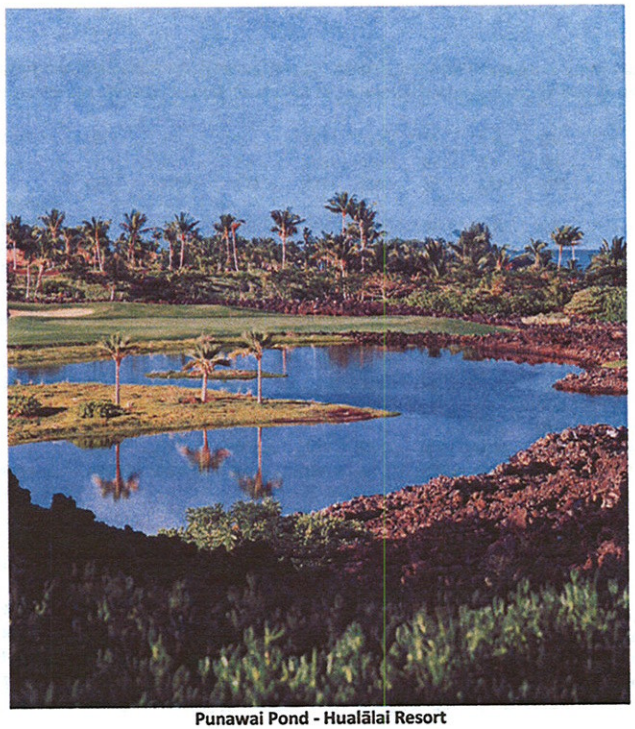
Hualālai Resort has restored a complex system of 13 natural anchialine ponds, and designed and constructed two manmade aquaculture ponds. Hualālai's ponds underwent a five-year labor-

intensive excavation process, removing alien grasses and shrubs, kiawe and mangrove forests, and seeding the ponds with sediment from existing pristine anchialine ponds.

After that, nature took its course: the `opae `ula and other microfauna returned and helped clean the water and balance the ecosystem, while awa (milkfish) and `ama `ama (mullet) solved algae blooms. The self-sustaining Punawai Pond produces enough shrimp, clams and oysters for all the resort's restaurants.

In 2005, Hualālai received a national award from the Environmental Protection Agency for their pond restoration efforts. In 2007, Hualālai Resort's fishpond restoration of historic Waiakauhi received The Hawai‰i Visitors & Convention Bureau's *Lehua Maka Noe* Award in recognition of the preservation and perpetuation of Hawai‰i's culture and history.

As noted by the director of natural resources at Hualālai Resort for more than a decade, David Chai notes, "We're a resort, but something like this can be easily duplicated in a lot of places. It's really a matter of integrating development with the natural features, wherever you are. It's about taking care of our environment and culture, and knowing that you're trying to do things the right way."



Punawai Pond - Hualālai Resort

Hualālai Resort has high elevation potable wells above the project; in addition, Hualālai has lower elevation brackish wells. Hualālai has resort, golf course and residential development along the coastal area. There are no apparent negative impacts to their nearshore waters, fishponds and anchialine ponds; in fact, they were recognized by the EPA and travel entities for the quality of their ponds and serve their guests food grown in the pond.

Kūki‰o

Kūki‰o (adjoining Hualālai Resort) is a private oceanfront club and residential community, on the Kona Coast of the Big Island. Kūki‰o is the only private equity Golf and Beach Club on the Big Island of Hawai‰i. The Beach Club includes a full service Member's Clubhouse, extensive spa and fitness facilities, dining pavilion, beach bar, a ten-hole Tom Fazio-designed short course and Kūki‰o's signature Outdoor Pursuits Ocean Sports program. Upslope from the short course is Kūki‰o's eighteen-hole Tom Fazio-designed championship golf course.

Following is a summary of the wells serving the Resort:

Kūkiʻo

Well Name	Casing Dia. (in.)	Ground Elev. (ft.)	Well Depth (ft.)	Use Cat.	Yr. Drill	Use Yr.	Init. Head (ft.)	Pump Capacity (gpm)	Average Pumpage (MGD)	High Avg. Pumpage (MGD)
KI-1	14	591	610	IRR	1990	01	1.6	500	0.31	0.33
KI-2	12	551	570	IRR	1991	00	1.2	500	0.38	0.40
KI-3	16	592	618	IRR	1992	01	0	500	0.32	0.36
Kūkiʻo Lagoon 1	72	7	12	OTH	2002	03	0.94	1500		
Kūkiʻo Lagoon 2	72	8	12	OTH	2002	03	0.94	1500		
Kūkiʻo Obs C	2	9	20	OBS	2001	01	0.25	0		
Kūkiʻo Obs D	2	8	18	OBS	2001	01	0.25	0		
Kūkiʻo Obs E	2	8	20	OBS	2001	01	0.25	0		
Kūkiʻo Obs F	2	7	17	OBS	2001		0.5	0		

Hualālai Resort (Center) and Kūkiʻo Resort - image from kukio.com

Anchialine pond restoration efforts at Kūkiʻo included removal of vegetation in and around the pools as well as the removal of sediments from these ponds. Much of these restoration activities involve the removal of accumulated sediment down to the underlying pāhoehoe bedrock. These activities all serve to increase the concentration of inorganic nutrients in the anchialine pools. In addition, removal of unwanted predatory alien fishes from some of the anchialine pools. This action should serve to improve water quality (i.e. lower chlorophyll-a and ammonia nitrogen, as well as increase clarity by allowing native grazing species to recolonize the cleared pools.

Where elimination of alien species is not possible, remaining restoration activities include the stocking of those pools at appropriate densities with specific native grazing marine fishes that are euryhaline (i.e. species that tolerate wide ranges in salinity) that serve to reduce unwanted algae that otherwise tend to dominate the system. The restoration of pools in the central complex has greatly increased the water surface area thereby increasing the availability of appropriate habitat.

Kūkiʻo has high elevation potable wells above the project; in addition, there are lower elevation brackish wells. Kūkiʻo has golf course and residential development along the coastal area. There are no apparent negative impacts to their nearshore waters, fishponds and anchialine ponds.

Mauna Lani Resort - Kalahuipuaʻa Fishponds

The Mauna Lani Resort is the home of both the Mauna Lani Bay Hotel & Bungalows and the newly renovated Fairmont Orchid at Mauna Lani. Mauna Lani's residential developments are The Point Estates, The Cape, Champion Ridge, 49 Black Sand Beach, Pauoa Beach and KeKailani. Condominiums at the resort are The Terraces, The Point, The Islands, The Villages, The Palm Villas, The Golf Villas, The Fairways, Kulalani and Ka Milo. There are 36-holes of golf in two golf courses designed by Robin Nelson, Nelson & Haworth. Recently a commercial area, The Shops at Mauna Lani, anchored by Foodland's marketplace was added.

Following is a summary of the wells serving the Resort:

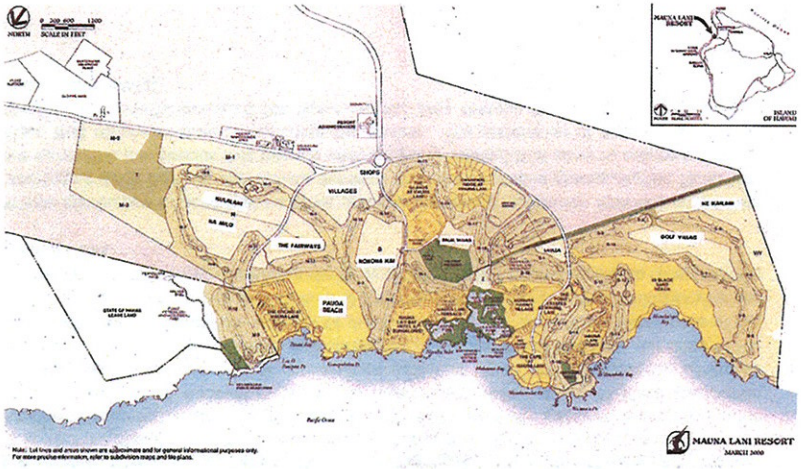
Mauna Lani Resort

Well Name	Casing Dia. (in.)	Ground Elev. (ft.)	Well Depth (ft.)	Use Cat.	Yr. Drill	Use Yr.	Init. Head (ft.)	Pump Capacity (gpm)	Average Pumpage (MGD)	High Avg. Pumpage (MGD)
Mauna Lani 8	12	147	165	IRR	1999	02	2.85	550		
Mauna Lani 9	12	143	161	IRR	1999	02		450		
North	12	93	100	IRR	1991	92	2	450	0.62	1.49
Waikoloa MLR 1	20	1147	1242	MUN	1992	99		1000	1.71	1.69
Waikoloa MLR 2	20	1178	1275	MUN	1993	98	6.3	1000	1.52	1.69
Culvert	12	124	160	IRR	1991	92		350	0.25	0.33
Entrance	8	137	180	IRR	1991	92	2	250	0.04	0.18
Fire Station	12	60	70	IRR	1988	88	1.3	425	0.44	0.61
Highway	12	121	130	IRR	1988	92	2	425	0.48	0.56
Mauna Lani SW 1	18	45	310	OTH	1991	91	1.8	3000		
Mauna Lani SW 2	18	28	188	OTH	1991		1.5			
Stp				OTH		90			0.35	0.46

Seven major ponds make up the Mauna Lani ponds - Kalahuipuaʻa, Kahinawao, Waipuhi, Waipuhi Iki, Hopeʻala, Milokukahi and Manoku.

The ponds were used to raise mullet, milkfish, shrimp and other sea life strictly for the consumption of Aliʻi. Continuing the tradition of stewardship, Mauna Lani Resort cares for the ancient complex.

Today, the ponds are stocked, and the schools of mullet and awa are moved from pond to pond to feed in different stages of development.



Since 1989, Mauna Lani Bay Hotel & Bungalows has received juvenile honu (turtle) from Oahu's Sea Life Park, and has raised them in the saltwater ponds of the hotel.

The honu are cared for until they grow to a size and weight that are deemed appropriate for release into the wild. This release occurs every July 4th, Independence Day.

Since the program's inception, Mauna Lani has nurtured 217 juvenile honu in its saltwater ponds.

During a 2009 survey at Kaloko-Honokōhau National Historic Park, a large sea turtle was discovered to be one of Mauna Lani's 1999 Turtle Independence Day releases.

The honu is about 14 yrs old, and weighed 267 lbs. To date this is the oldest of Mauna Lani's turtle 'ohana to be found surviving on its own.

(Photo from maunalani.com)

Two of the world's top travel publications, Condé Nast Traveler & National Geographic Traveler magazines, have heaped praise on Mauna Lani for their longstanding commitments to environmental and cultural stewardship.

Condé Nast Traveler magazine named Mauna Lani Resort as one of the "World's Top earth Friendly Getaways" in their January 2008 issue. Condé Nast Traveler also recognized Mauna Lani Resort's green sea turtle program as an ecotourism attraction.

These recognitions are reinforced by National Geographic Traveler magazine. In their April 2008 issue, they named Mauna Lani Resort to their prestigious "Stay list" for their eco-stewardship efforts.

Mauna Lani Resort has high elevation potable wells; in addition, Mauna Lani has lower elevation brackish wells. Mauna Lani has resort, commercial, golf course and residential development along the coastal area.

There are no apparent negative impacts to their nearshore waters, fishponds and anchialine ponds; in fact, they were recognized by travel entities for the quality of their ponds. Likewise, they use their ponds to raise green sea turtles and annually release them into the wild; one of these visited the Kaloko-Honokōhau National Historical Park.

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Appendix E

Botanical Survey of Kaloko Properties
Isle Botanica
December 2006

Botanical Survey

of

Kaloko Properties

North Kona
Island of Hawai'i

by

Art Whistler, Ph.D.
Isle Botanica
Honolulu, Hawai'i

Report prepared for

Wilson Okamoto Corporation
Honolulu, Hawai'i

December 2006

INTRODUCTION

The current project site encompasses about 1296 acres located in North Kona on the island of Hawai'i. It is situated north of Kona town, and mauka of Ka'ahumanu Highway and the "Kaloko Light Industrial Subdivision," which includes Costco. It is bordered on the west side by the highway, and extends mauka (eastward) to eventually straddle both sides of Hina Lani Road (Fig. 1). The area comprises lava flows of various ages that are covered mostly with a highly disturbed scrub and grass vegetation. However, a relatively undisturbed dryland forest, one of the most biologically diverse yet most heavily damaged ecosystems in the State, covers one area comprising most of the southeastern portion of the property.

BACKGROUND

The USFWS has long recognized the importance of the dryland forest on the site for its unique assemblage of native plants, and has indicated their desire to a preserve a portion of the property for its botanical value. They noted that the dryland forest located on the site is one of the last dryland forests still relatively free of introduced, alien grasses and cattle. The area has remained in such good condition because the substrate is a young lava flow that has acted as a deterrent to cattle, fire, and the spread of alien grasses (USFWS pers. comm. 2006). This patch of forest contains, or has contained, several federally listed endangered plant species: *'aiea* (*Nothocestrum breviflorum*), *ma'oloa* (*Neraudia ovata*), *Cyperus faurieri*, and *hala pepe* (*Pleomele hawaiiensis*). These species are also listed by the State as endangered species (DLNR 1998).

At least two botanical surveys in or adjacent to the area have been conducted. The first was carried out in conjunction with a proposed transmission line that would have crossed the property (CH2M Hill 1993). The second survey was done for the Kaloko town center (site of the present business district that includes Costco), which is adjacent to the current study site (Char and Associates 1995). The CH2M Hill botanical survey crossed the present study area, but also extended in either direction several miles, so the two areas are not exactly comparable. It listed the presence of 101 plant species in that corridor. Three of the species recorded are federally listed endangered species. Five individuals of the sedge *Cyperus fauriei* (known at that time as *Mariscus fauriei*) were noted growing on a single boulder at about 115 m elevation on the 'a'a flow. Two trees of *Nothocestrum breviflorum* were noted growing on the 'a'a flow at 110 m elevation. Two mature individuals of *Neraudia ovata* were noted growing on the 'a'a lava flow at 115 m elevation. The checklist for the Char and Associates botanical survey on the property adjacent to the present study site listed a total of 47 species present, but none of these are federally listed.

In 2003, the USFWS sent a team over for a reconnaissance of the site (USFWS 2003a & b). They noted finding one live specimen of *Neraudia ovata* in the study area, and reported making "a sweep of the area looking for the other four known plants but found none of them. We suspect they may be dead." They also noted the presence of good-sized individuals of *Bidens micrantha* spp. *ctenophylla* (*ko'oko'olau*) in low numbers and one dying *Pleomele hawaiiensis* (*hala pepe*) as well as several other native plant species.

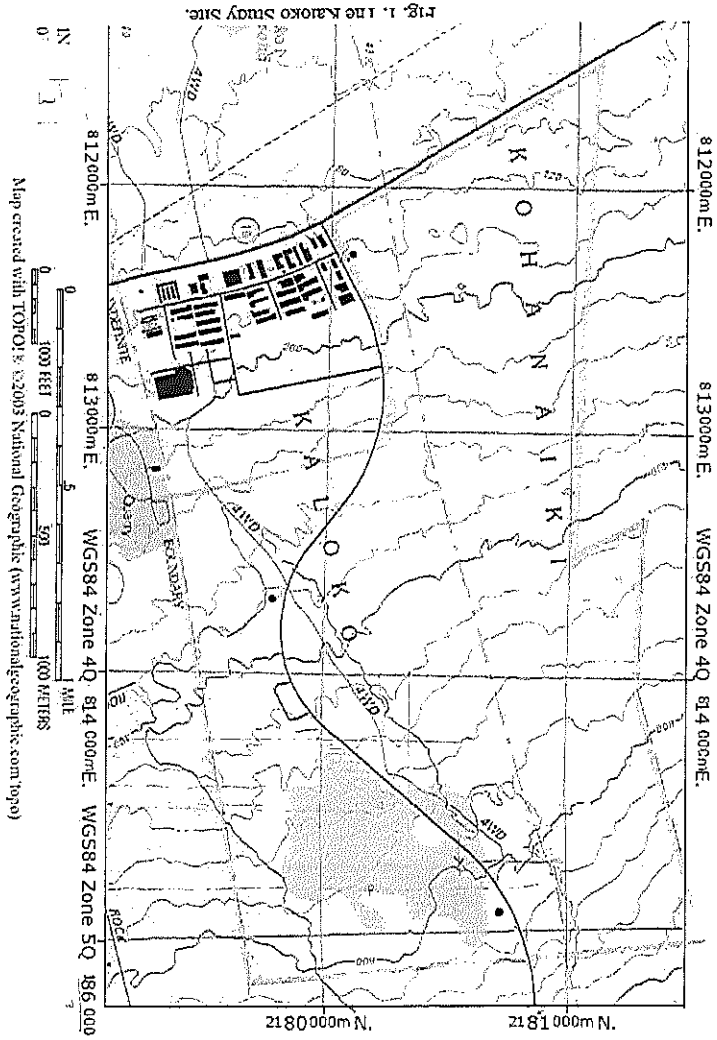

Fig. 1. The Kaloko Study Site.

METHODOLOGY

Before the fieldwork was carried out, a review of the literature was undertaken by the Principal Investigator (PI). The current status of the endangered species previously reported from the site was checked using the official database of threatened and endangered species (USFWS 2005). This list is identical to the State of Hawai'i list of threatened and endangered plant species. In addition, information about threatened and endangered plant species found in the area was extracted from the Hawai'i Natural Heritage Program database (Anon. 2005) of Federally listed plant species (Fig. 2).

After the review of the existing literature, a botanical field survey at the Kaloko site was conducted by a two-person botanical team consisting of the PI (Art Whistler) and a Field Assistant (Beate Neher), from 1 to 6 September 2006. All plant species encountered during the survey were recorded, along with an indication of their frequency. Particular care was taken in the area of dryland forest and other 'a'a areas, since this is where most of the native species and all of the endangered species have been reported. New lists were made for each vegetation type and/or day, and these were combined into a comprehensive checklist of all plants found at the study site (see Appendix). Notes were also taken on vegetation types present at the site, indicating the dominance and frequency of the plant species present. This was later analyzed and written up to form the vegetation section below.

Most of the species encountered during the fieldwork were familiar to the field team. Only one plant observed during the survey defied attempts at identification in the field. It was taken back to Honolulu to the Bishop Museum to compare with specimens there, and was eventually identified with the help of the Bishop Museum Herbarium staff.

THE VEGETATION

Four types of vegetation can be recognized on the Kaloko property: (1) Managed Land Vegetation; (2) Leucaena Scrub, which can be divided into a lowland subtype with extensive amounts of *Pennisetum setaceum* between the trees, and an upland subtype with *Kalanchoē pinnatum* and *Panicum maximum* dominating the ground cover; (3) Christmas-Berry Scrub that occurs on recent 'a'a flows, and which can be divided into two subtypes, one with only scattered Christmas berry trees and a few native species, the other with a similar, denser, scrub forest; and (4) Dryland Forest.

(1) Managed Land Vegetation

This comprises the areas of the parcel that are under periodic or frequent management, such as the edges of roads. It also includes the large quarry on the south side of the dryland forest. This is a relatively minor component of the overall vegetation on the property, and is entirely dominated by alien weedy species, such as the grasses *Digitaria ciliaris* (large crabgrass) and *Rhynchelytrum repens* (Natal redtop), and the dicot herbs *Tridax procumbens* (coat buttons), *Chamaesyce hirta* (garden spurge), *Chamaesyce hyssopifolia*, *Desmodium tortuosum* (Florida beggarweed), *Macroptilium lathyroides* (cow pea), *Boerhavia coccinea*, *Waltheria indica* (*'uhaloa*, a native species), and *Sida rhombifolia* (Cuba jute).

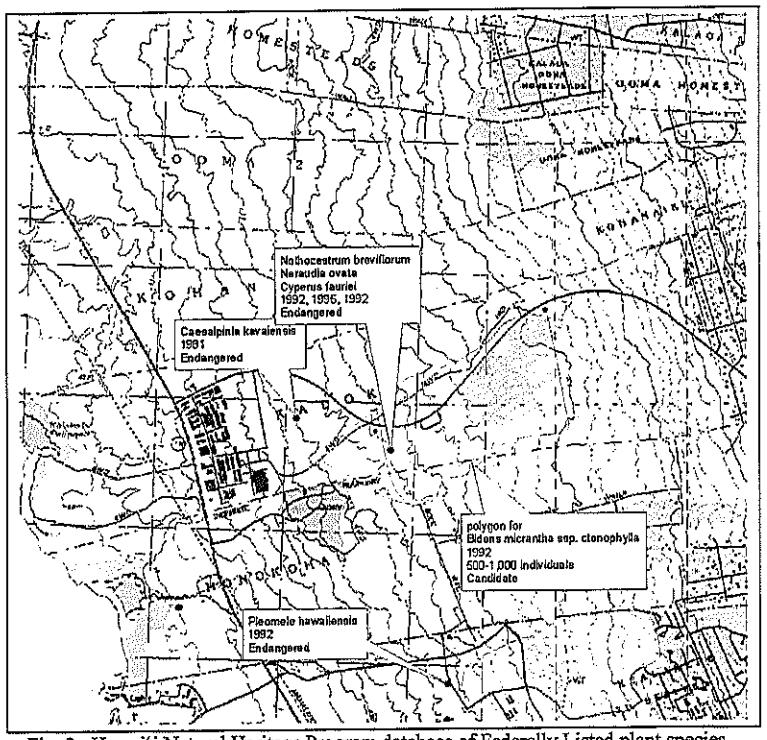

Fig. 3. Hawai'i Natural Heritage Program database of Federally Listed plant species.

(2) *Leucaena* Scrub

This is the type of vegetation found on areas of older lavas dominated by the alien scrubby tree *Leucaena leucocephala* (*koa haole*). It is not a homogeneous type of vegetation, since with increasing elevation along the north side of the road, its density and the species associated with it change. On the lower portions (Fig. 3), *koa haole* is mostly 1–2 m in height, scattered in an open-to-dense matrix of *Pennnisetum setaceum* (fountain grass). Several other trees and shrubs are found here, but in low numbers. This includes the alien tree species *Prosopis pallida* (*kiawe*) and *Schinus terebinthifolius* (Christmas berry), the alien shrub *Acacia farnesiana* (klu), the Polynesian introduction *Morinda citrifolia* (*noni*), and the native shrubs *Dodonaea viscosa* (*'a'ali'i*), *Psydrax odorata* (*'alahe'e*), and *Sida fallax* (*'ilima*). Also present are plants such as the shrubs *Indigofera suffruticosa* (indigo) and *Waltheria indica* (*'uhaloa*), the herbs *Chamaecrista nictitans* (*lau-ki*), *Talinum triangulare* (talinum), and *Portulaca pilosa* (*'ihi*), and

the grasses *Rhynchelytrum repens* (Natal redtop) and *Heteropogon contortus* (*pili*). This might be better described as a mosaic vegetation, with patches of *koa haole* alternating with areas entirely dominated by the fountain grass, but this grass is also found in the partial shade of the *koa haole*, especially when its canopy is thin. It might equally validly be labeled as a fountain grass grassland with associated *koa haole* trees.

At the upper (eastern or mauka) end of the property, the *koa haole* is also dominant, but is denser and taller (2–4 m in height). Instead of forming a mosaic with fountain grass beneath, it forms a dense monodominant scrub forest (Fig. 4). Other tree species are interspersed with it, particularly the native trees or shrubs *Psydrax odorata* (*'alahe'e*), *Diospyros sandwicensis* (*lama*), and *Sophora chrysophylla* (*mamane*), and the alien trees *Schinus terebinthifolius* (Christmas berry) and *Grevillea robusta* (silk oak). The latter two are large and scattered, but appear to be invasive and spreading. The ground cover in this upper area is dominated by *Kalanchoë pinnatum* (air plant) and *Panicum maximum* (Guinea grass), with some *Pennisetum setaceum* (fountain grass) in patches (Fig. 5). The native herb *Peperomia leptostachya* (*'ala'ala-wai-nui*) is occasional on rocks. In disturbed areas across the road from this, next to the upper water tank, the *Leucaena* scrub has an understory of fountain grass (Fig. 6). This differs from the lowland type of *Leucaena* scrub in that the trees are taller and more densely arranged.

Leucaena scrub is classified as disturbed, since fires periodically sweep through the area and goats are known to be present. These two factors account for the dominance of alien species, which are better adapted to these disruptive conditions than are the native species. According to the flora of Hawai'i (Wagner et al. 1999), fountain grass " is rapidly expanding its range in the Kona district of Hawaii." Introduced into the Kona District "in the early 1900s as an ornamental, [it] has aggressively spread and now dominates abandoned pastures, young lava flows, and burn areas. Fountain grass poses one of the most serious contemporary conservation problems because it is disrupting the more sparsely vegetated lowland native dry forests and shrublands, which contain several endangered and many candidate endangered plant species."

(3) Christmas-Berry Scrub

This is the type of vegetation on more recent lava flows, ones that are distinctly 'a'a lava. An irregular tongue of this runs down the slope near the northern boundary of the study site. In the lower portion of the study site, this vegetation is very sparse on the inhospitable surface, but scattered trees of the alien *Schinus terebinthifolius* (Christmas berry) comprise the most common species (Fig. 7). Also found here are scattered individuals of the native trees or shrubs *Capparis sandwichiana* (*pua pilo*), *Psydrax odoratum* (*'alahe'e*), *Metrosideros polymorpha* (*'ohi'a lehua*), *Myoporum sandwicense* (*naio*), as well as the introduced trees *Leucaena leucocephala* (*koa haole*) and *Morinda citrifolia* (*noni*).

The ground cover is also very sparse, with scattered clumps of *Pennisetum setaceum* (fountain grass) found mostly in pockets of soil or pahoehoe, and perhaps being the most common species found here. There were also a few patches of *Ipomoea indica* (*kowali-'awa*) and *Cocculus trilobus* (*huehue*), and even smaller amounts of the alien species *Nephrolepis multiflora* (hairy swordfern), *Lantana camara* (lantana), and *Pluchea carolinensis* (pluchea). Because the vegetation is so sparse, it hardly qualifies as vegetation at all, just scattered trees with equally scattered clumps of herbaceous species.

At higher elevations in this habitat on the same flow, where increasing rainfall and/or cloud cover makes the habitat more hospitable to trees, the vegetation comprises a low closed forest

(Fig. 8) dominated by Christmas berry, with lesser amounts of the native trees *Psydrax odorata* (*'alahe'e*), *Sophora chrysophylla* (*mamane*), and *Diospyros sandwicensis* (*lama*). Tall individuals of *Grevillea robusta* (silk oak) are scattered in the area. The native shrub *Dodonaea viscosa* (*'a'ali'i*) is sometimes common in clearings on the lava. No individuals of *Metrosideros polymorpha* (*'ohi'a lehua*), *Reynoldsia sandwicense* (*'ohe*), *Pleomele hawaiiensis* (*hala pepe*), or *Myoporum sandwicensis* (*naio*) were found in this scrub forest. Because of the dense shade, very little ground cover is present, but that which is present comprises mostly *Panicum maximum* (Guinea grass) and *Kalanchoë pinnatum* (air plant). However, some fountain grass is found in clumps on the lava flow there.

Like the *Leucaena* scrub, this vegetation is classified as disturbed, since fires periodically sweep through the area, and goats are known to be in the area. It somewhat matches the description of the "Lowland Dry Shrublands" described in Wagner et al. (1999), which is described as occurring in leeward situations on most of the main islands, at 100 to 600 m elevation, and being open and not exceeding 3 m in height.

(4) Dryland Forest

This is the open to closed native forest (Figs. 9 and 10) occurring on the relatively recent lava flow comprising most of the central portion of the southern half of the study area. Because of the rugged 'a'a lava, the vegetation is difficult for feral grazing animals to visit. Over much of the area the trees are separated from each other, and this, combined with the virtual absence of fountain grass, has caused the area to be spared from grazing and wildfires. Consequently, the forest is relatively intact, and was home until recently, at least, to four endangered species: *Nothocestrum breviflorum*, *Neraudia ovata*, *Cyperus fauriei*, and *Pleomele hawaiiensis*.

The most common trees are probably the native species *Diospyros sandwicensis* (*lama*), *Psydrax odoratum* (*'alahe'e*), *Capparis sandwichiana* (*pua pilo*; often more of a shrub than a tree), and *Sophora chrysophylla* (*mamane*). Also occasional are the native trees *Metrosideros polymorpha* (*'ohi'a lehua*), *Reynoldsia sandwicensis* (*'ohe*), *Myoporum sandwicensis* (*naio*), and *Dodonaea viscosa* (*'a'ali'i*), as well as scattered individuals of the endangered tree-like monocot *Pleomele hawaiiensis* (*hala pepe*). The only alien tree species noted in this open forest were *Jacaranda mimosifolia* (jacaranda), the Polynesian introduction *Morinda citrifolia* (*noni*), *Schinus terebinthifolius* (Christmas berry), and *Leucaena leucocephala* (*koa haole*). The latter two species, especially Christmas berry, sometimes form clumps and in some places dominate the edges of the dryland forest. The southern boundary of this forest has recently been bulldozed in quarry activities, and fountain grass is spreading in this newly created disturbed habitat (Fig. 11).

The ground cover in the dryland forest is very sparse, due to the inhospitable growing conditions. The most common species in this category are *Lantana camara* (lantana), the native vines *Cocculus trilobus* (*huehue*) and *Ipomoea indica* (*kowali-'awa*), *Pennisetum setaceum* (fountain grass), *Nephrolepis multiflorum* (hairy swordfern), and an escaped ornamental vine *Lophospermum erubescens* (larger roving sailor).

Overall, this vegetation comprises a good quality dryland forest, based upon the flora and the dominance of native species. The native flora is virtually the same as that found in the list of the native flora on the whole site shown in Table 1 (below), with the possible exception of *Heteropogon contortus* (*pili*), which was found elsewhere on the study site but not in the dryland forest.

THE FLORA

A total of 93 plant species (see Appendix) was recorded in the study area, but this does not include a few cultivated species planted along the roadsides. Twenty-five of the species encountered are native and eleven of these native species are endemic. Indigenous plants are species that are native to a region or place, but are also found elsewhere. Endemic plants are species restricted to a single region or area, i.e., in the case of Hawai'i, they are found only in Hawai'i. In biodiversity terms, the endemic status is the more important of the two categories, since if a species belonging to it is endangered or threatened in Hawai'i, it would likewise be classified globally. Indigenous species, however, can be classified as threatened or endangered in Hawai'i, but may be common elsewhere in the Pacific. Over 90% of the native plants in Hawai'i are endemic, one of the highest rates in the world.

The majority of the 93 species encountered during the survey are naturalized "alien" plants that were accidentally or intentionally introduced to Hawai'i, but which have now become established in the islands and can spread on their own. The checklist of Char and Associates (1995) included several other species found on the adjacent property that were not found during the present survey: *Bidens cynapiifolia* (beggar's tick), *Cucumis dipsaceus* (wild cucumber), *Tephrosia purpurea* (*'auhuhu*), *Abutilon incanum* (hoary abutilon), *Boerhavia repens* (*alena*), and *Solanum americanum* (*popolo*). All of these except *Tephrosia purpurea* are herbaceous species that die back during the dry season, and consequently would likely turn up in the current study area during a survey in the rainy season. Three of them are native (or questionably so), but none are endemic.

Only one of the native species found during the present survey, *Pleomele hawaiiensis*, is a federally listed endangered species. Hawai'i Natural Heritage Program database map (Fig. 2) shows a record of *Caesalpinia kavaiensis* (*uhiuhi*) as occurring between the current study site and the industrial area, but the date on this record is 1981 and the tree has probably died by now, since it has not been recorded there since that time. (Also, it is located outside of the present study site.) A list of native species found at the study site is shown in Table 1. The other three endangered plant species, *Cyperus fauriei*, *Nothocestrum breviflorum*, and *Neraudia ovata*, previously reported from the dryland forest were not encountered during the present survey, and may have disappeared from the site.

DISCUSSION

Only one of the species encountered during the survey is Federally Listed as Threatened or endangered, *Pleomele hawaiiensis* (Fig. 12). According to the USFWS, "six to eight populations are currently known: one to three in the Puu Waawaa region of Hualalai on State-leased and private land, two in the Kaloko/Kaloao area on private land, two in the Kapua/Kahuku area on private land, and one on Holei Pali within Hawaii Volcanoes National Park. These populations total 250–300 individuals, of which over 75 are found at Kaloko. Kaloko represents one of only

Table 1. Native species found at the study site

Argemone glauca (Papaveraceae)	pua kala	Endemic
Bidens micrantha		

subsp. *ctenophylla* (Asteraceae)	ko'oko'olau	Endemic
Capparis sandwichiana (Capparaceae)	pua pilo	Endemic
Chamaesyce celastroides (Euphorbiaceae)	'atoto	Endemic
Cocculus trilobus (Menispermaceae)	huehue	Indigenous
Diospyros sandwicensis (Ebenaceae)	lama	Endemic
Dodonaea viscosa (Sapindaceae)	'a'ali'i	Indigenous
Doryopteris decipiens (Adiantiaceae)	kumuniu	Endemic
Heteropogon contortus (Poaceae)	pili grass	Indigenous?
Ipomoea indica (Convolvulaceae)	koali-'awa	Indigenous
Lipochaeta subcordata (Asteraceae)	---------	Endemic
Metrosideros polymorpha (Myrtaceae)	'ohi'a lehua	Endemic
Myoporum sandwicense (Myoporaceae)	naio	Indigenous
Osteomeles anthyllidifolia (Rosaceae)	'ulei	Indigenous
Peperomia leptostachya (Piperaceae)	'ala'ala-wai-nui	Indigenous
Plectranthus parviflorus (Lamiaceae)	spurflower	Indigenous
Pleomele hawaiiensis (Agavaceae)	halapepe	Endemic
Psilotum nudum (Psilotaceae)	moa	Indigenous
Psydrax odoratum (Rubiaceae)	alahe'e	Indigenous
Reynoldsia sandwicensis (Araliaceae)	'ohe	Endemic
Scaevola sericea (Goodeniaceae)	naupaka	Indigenous
Senna gaudichaudii (Fabaceae)	kolomona	Indigenous
Sida fallax (Malvaceae)	'ilima	Indigenous
Sophora chrysophylla (Fabaceae)	mamane	Endemic
Waltheria indica (Sterculiaceae)	'uhaloa	Indigenous

two known populations that are successfully regenerating" (USFWS 2006, pers. comm.). During the present survey, only about 24 plants were observed, but since counting individuals was not part of the project, this should not be judged to be indicative of a decline in the number of individuals currently there. The species is not included on the Hawai'i Natural Heritage Program Database map (Fig. 2).

Several other endangered species have been reported from the dryland forest area, but were not found during the present survey. According to the USFWS, the endangered *Nothocestrum brevifolium* is "historically known from 15 locations extending from the southern Kohala Mountains, south along the leeward side of the Big Island, to the South Point area. Currently, six populations are known. Two of the 53 known individuals of this species occur in Kaloko (USFWS pers. comm. 2006)." The Hawai'i Natural Heritage Program Database (Fig. 2) noted a location of the plant in the dryland forest and dates this record to 1992. Rex Palmer observed the plant growing in the dryland forest only three years ago (pers. comm. 2006). The Division of Forestry and Wildlife (DOFAW) representative Lyman Perry (pers. comm. 2006) noted his belief that "...*Nothocestrum* [has] not been observed in this area for quite some time...The nearest *Nothocestrum* locations that I know of are in Kaupulehu (above the road at the 28 mile marker in the NTBG 6 acre enclosure)." A site visit by USFWS personnel in 2003 looking at endangered species did not report finding it either (USFWS 2003 a&b).

A third endangered species, *Neraudia ovata*, has been reported from the dryland forest. Palmer (pers. comm. 2006) noted its presence there in 2003 growing under trees near to where homeless people are known to camp. The presence of a single flowering and fruiting plant was reported there in 2003 (USFWS 200 3a&b). Lyman Perry (pers. comm. 2006) noted "...*Neraudia* [has] not been observed in this area for quite some time...The nearest known location of *Neraudia* was the lava flow behind COSTCO on Hina Lani Street but those plants died in the last couple of years." The Hawai'i Natural Heritage Program Database (Fig. 2) shows its occurrence in the area in 1995.

A fourth endangered species has been reported from the dryland forest, the endemic *Cyperus fauriei* (formerly known as *Mariscus fauriei*). According to the USFWS, "only four populations are currently known: 20–30 plants on State owned land on Molokai, 22 plants in two populations on State owned land on the southern end of the island of Hawaii, and five plants in Kaloko, on private land" (USFWS pers. comm. 2006). This information about its presence at Kaloko is probably based on the record from the survey described in CH2M Hill (1993). The Hawai'i Natural Heritage Program Database (Fig. 2) shows its presence there in 1992, apparently also based on the CH2M Hill report.

The Hawai'i Natural Heritage Program Database map (Fig. 2) also shows a record of the federally listed endangered tree *Caesalpinia kavaiensis* (*uhiuhi*) as occurring in the area just west of the study site and east of the industrial area, but it apparently has not been seen for years and was not noted in the USFWS 2003 site visit report (USFWS 2003a&b).

CONCLUSIONS AND RECOMMENDATIONS

Based upon the survey, there are three main kinds of vegetation at the site: (1) disturbed scrub dominated by *Leucaena leucocephala* (*koa haole*) in combination with *Pennisetum setaceum* (fountain grass) in the lower part of the study site, and with *Kalanchoë pinnatum* (air plant) and *Panicum maximum* (Guinea grass) in the upper part; (2) disturbed scrub dominated by *Schinus terebinthifolius* (Christmas berry); and (3) relatively undisturbed dryland forest. The two kinds of disturbed vegetation occupy most of the site. The USFWS, based on notes from 1996, reported their belief that the dryland forest was approximately 200 acres (80 hectares) in area (USFWS pers. comm. 2006). By this reckoning, the disturbed vegetation comprises about 1100 acres (1296 minus 200) of the site. No Federally listed endangered or threatened plant species were recorded in this disturbed area.

The dryland forest is a different story. It constitutes valuable and irreplaceable habitat for Hawai'i's unique biota, and consequently has major cultural and biological significance. It is one of the last few remaining, relatively undisturbed patches of this dryland forest habitat in Hawai'i. Twenty-five native species were recorded from this site, eleven of them endemic to Hawai'i (i.e., found nowhere else in the world). Four of these (three found during previous surveys only, and one during the present and previous surveys) are federally listed endangered species. Some of these species are very rare since they are restricted to only a few localities. This combination of rare vegetation, rare native species, and federally listed endangered species make this remnant dryland very important to the biodiversity of Hawai'i. The USFWS is bound by law to protect these species and consequently they will need to protect this area of dryland forest where they occur. However, the USFWS has previously noted that they would not hinder any development plans for the areas of disturbed vegetation at the site if the dryland forest were to be set aside and given protection status (USFWS. pers. comm. 2006). Consequently, the

owners will have to negotiate with the USFWS and DOFAW on just how much land needs to be set aside for this protection. They may also have to overcome local opposition to the project, so they should make it clear that they are also interested in preserving these unique and rare species, within the confines of development for the major portion of the parcel.

It is also recommended that of some of the rare and endemic species occurring on the site or in the general area should be considered for any landscaping that will be done, such as around utility buildings and public structures. This would be a win-win situation. Some of the species make attractive ornamentals, and are already adapted to the dryland conditions at the site. Thus they require little maintenance and watering. Using rare or culturally significant species would also help to alleviate any local or governmental concerns that the project would be detrimental to the survival of these rare species. Some of these species are already being propagated by local gardeners and gardens, such as the nearby Amy Greenwell Garden. These may be available for purchase, or these individuals or gardens could be hired to do the local plant landscaping. Some species recommended for this are as follows:

Aleurites moluccana (*kukui*)—This species is a Polynesian introduction to Hawai'i rather than a native species, but it has important cultural significant since it seeds were traditionally used for night time illumination (hence its English name candlenut. Currently the seeds are used to produce massage oil and the fruits are fashioned into attractive, jet-black seed leis. It gray-green leaves and large stature make it a popular ornamental tree in Hawai'i.

Bidens micrantha subsp. *ctenophylla* (*ko'oko'olau*)—An endemic shrub that was formerly a candidate, federally listed endemic species. It is restricted mostly to this part of the island of Hawai'i and has small, attractive, yellow, sunflower-like flowers (Fig. 13)

Capparis sandwichiana (*pua pilo*, *pua pilo*)—An endemic shrub or small tree with large, attractive white, fragrant flowers. It relatively rare in Hawai'i, but does well on lowland lava flows.

Erythrina sandwicensis (*wiliwili*)—A spreading endemic tree with showy seasonal red flowers, found in the area, but not recorded from the study site. It is a popular, long-lived, native ornamental tree in Hawai'i that is related to the ornamental coral tree (*Erythrina variegata*).

Metrosideros polymorpha (*'ohi'a lehua*)—This is the indigenous, medium-sized tree covering much of the island, and has attractive red, powderpuff-like flowers. Some varieties also have attractive gray-green leaves. It is uncommon at the site, probably because the area does not get enough rainfall to allow it to flourish, but it dominates the intact forests upslope.

Myoporum sandwicense (*naio*)—An indigenous small tree or shrub with small, fragrant white flowers. Its English name is false sandalwood, indicative of its fragrant wood once used like sandalwood. The plant is easily grown from cuttings.

Osteomeles anthyllidifolia (*'ulei*)—A sprawling indigenous shrub that makes a nice shrubby ground cover. It has attractive but small, white, rose-like flowers (it is a member of the rose family).

Pleomele hawaiiensis (*halapepe*)—A federally listed endangered endemic species. This yucca-like plant is similar to the money tree (*Dracaena marginata*) that is a popular ornamental plant in Hawai'i.

Psydrax odoratum (*alahe'e*)—A small indigenous tree or shrub fairly common at the site, to which it is well adapted. It has attractive dark green leaves, thick canopy, and baseball-sized clusters of fragrant, attractive white flowers.

Reynoldsia sandwicensis (*'ohe*)—A large, fast growing endemic tree with an open canopy.

Senna gaudichaudii (*kolomona*)—Small indigenous tree with pale yellow flowers. It is similar to the scrambled eggs tree (*Senna surattensis*) that is a popular ornamental tree in Hawai'i, and which is also naturalized at the site.

Sida fallax (*'ilima*)—An indigenous shrub common at the site. It is a popular ornamental in Hawai'i, where the orange mallow-like flowers are fashioned into exquisite leis.

Sophora chrysophylla (*mamane*)—An endemic small tree or shrub common on the Big Island, especially at higher elevations. It has attractive yellow, sweetpea-like flowers and an unusual, bead-necklace-like pod.

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TABLE 1. PLANT SPECIES CHECKLIST FOR THE KALOKO PROPERTY

The following is a checklist of the vascular plants inventoried during the field studies on the Kaloko planned development area. The plants are divided into three groups, Ferns (including fern allies), Monocots, and Dicots. Within these groups, the species are presented taxonomically by family, with each family and each species in the family in alphabetical order. The taxonomy and nomenclature of the ferns follow Palmer 2003 and the flowering plants (Monocots and Dicots) follow Wagner *et al.* (1999). In most cases, common English and/or Hawaiian names listed here have been taken from St. John (1973) or Porter (1972). Native plants are shown in **bold.**

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name, when known.
3. Biogeographic status. The following symbols are used.
   E = endemic (found only in Hawai'i).
   I = indigenous (native to Hawai'i as well as other geographic areas).
   P = Polynesian introduction (introduced to Hawai'i by Polynesians before the advent of the Europeans).
   X = Introduced or alien (not native, introduced to Hawai'i, either accidentally or intentionally, after the advent of the Europeans).
4. Relative frequency (abundant, locally abundant, common, locally common, occasional, uncommon, rare).

Species	Common Names	Status	Abundance
FERNS AND FERN ALLIES			
ADIANTACEAE (Maiden's-hair Family)			
Doryopteris decipiens (Hook.) J. Sm.	kumuniu	E	
NEPHROLEPIDACEAE (Sword Fern Family)			
Nephrolepis multiflora (Roxb.) Jarret ex Morton	hairy swordfern	X	
PSILOTACEAE (Psilotum Family)			
Psilotum nudum L.	moa	I	
POLYPODIACEAE (Common Fern Family)			
Phymatosorus grossus (Langsd. & Fisch.) Brownlie	laua'e	X	
MONOCOTS			
AGAVACEAE (Agave Family)			
Pleomele hawaiiensis Degener and I. Degener	halapepe	E	

Species	Common Names	Status
COMMELINACEAE (Spiderwort Family)		
Commelina benghalensis L.	hairy honohono	X
DIOSCOREACEAE (Yam Family)		
Dioscorea bulbifera L.	bitter yam, hoi	P
POACEAE (Grass Family)		
Cenchrus echinatus L.	sandbur	X
Chloris barbata (L.) Sw.	swollen fingergrass	X
Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	X
Digitaria ciliaris (Retz.) Koeler	large crabgrass	X
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	love grass	X
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	pili grass	I
Melinus minutiflora P. Beauv.	molasses grass	X
Panicum maximum Jacq.	Guinea grass	X
Pennisetum setaceum (Forssk.) Chiov.	fountain grass	X
Rhynchelytrum repens (Willd.) C.E. Hubb.	Natal redtop	X
DICOTS		
AMARANTHACEAE (Amaranth Family)		
Amaranthus viridis L.	slender amaranth	X
ANACARDIACEAE (Mango Family)		
Schinus terebinthifolius Raddi	Christmas berry	X
APOCYNACEAE (Periwinkle Family)		
Catharanthus roseus (L.) G. Don	Madagascar periwinkle	X
ARALIACEAE (Panax Family)		
Reynoldsia sandwicensis A. Gray	'ohe	E
ASTERACEAE (Sunflower Family)		
Ageratum conyzoides L.	ageratum	X
Bidens micrantha Gaud. subsp. *ctenophylla* (Sherff) Nagatga & Ganders	--------	E
Emilia fosbergii Nicolson	red pualele, emilia	X
Emilia sonchifolia (L.) DC.	pualele, emilia	X
Lipochaeta subcordata A. Gray	--------	E
Pluchea carolinensis (Jacq.) G. Don	pluchea	X
Senecio madagascariensis Poir.	fireweed	X
Tridax procumbens L.	coat buttons	X
BIGNONIACEAE (Bignonia Family)		
Jacaranda mimosifolia D. Don	jacaranda	X
Spathodea campanulata P. Beauv.	African tulip tree	X
BUDDLEIACEAE (Butterfly-bush Family)		
Buddleia asiatica Lour.	dogtail, heulo'ilio	X

Species	Common Names	Status
CACTACEAE (Cactus Family)		
Hylocereus undatus (Haw.) Britten & Rose	night-blooming cereus	X
Opuntia ficus-indica (L.) Mill.	prickly pear, panini	X
CAPPARACEAE (Caper Family)		
Capparis sandwichiana DC	pua pilo	E
CLUSIACEAE (Mangosteen Family)		
Clusia rosea Jacq.	autograph tree	X
CONVOLVULACEAE (Morning-Glory Family)		
Ipomoea indica (J. Burm.) Merr.	koali-'awa	I
Ipomoea obscura (L.) Ker-Gawl.	bindweed	X
CRASSULACEAE (Stonecrop Family)		
Kalanchoë pinnata (Lam.) Pers.	air plant	X
CUCURBITACEAE (Gourd Family)		
Coccinea grandis (L.) Voigt	ivy gourd	X
Momordica charantia L.	wild bittermelon	X
EBENACEAE (Ebony Family)		
Diospyros sandwicensis (A. DC.) Fosb.	lama	E
EUPHORBIACEAE (Spurge Family)		
Aleurites moluccana (L.) Willd.	candlenut, kukui	P
Chamaesyce celastroides (Boiss.) Croziat and Degener	'atoto	E
Chamaesyce hirta (L.) Millsp.	garden spurge	X
Chamaesyce hyssopifolia (L.) Small	--------	X
Macaranga tanarius (L.) Muell. Arg.	--------	X
Ricinus communis L.	castor bean	X
FABACEAE (Pea Family)		
Acacia farnesiana (L.) Willd.	klu	X
Chamaecrista nictitans (L.) Moench	partridge pea, lau-ki	X
Crotalaria pallida Aiton	smooth rattlepod	X
Desmodium incanum DC.	Spanish clover	X
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X
Indigofera suffruticosa Mill.	indigo, 'iniko	X
Leucaena leucocephala (Lam.) de Wit	koa haole	X
Macroptilium lathyroides (L.) Urb.	cow pea	X
Pithecellobium dulce (Roxb.) Benth.	'opiuma, Manila tamarind	X
Prosopis pallida (Humb. & Bonpl.ex Willd.) Kunth	kiawe, mesquite	X
Senna occidentalis (L.) Link	coffee senna	X
Senna gaudichaudii (Hook. & Arn.) H. Irwin & Barneby	kolomona	I

Species	Common Names	Status
FABACEAE (cont'd.)		
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona	X
Sophora chrysophylla (Salisb.) Seem.	mamane	E
GOODENIACEAE (Goodenia Family)		
Scaevola sericea Vahl	naupaka	I
LAMIACEAE (Mint Family)		
Hyptis pectinata (L.) Poir.	comb hyptis	X
Plectranthus parviflorus Willd.	spurflower	I
MALVACEAE (Mallow Family)		
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X
Malvastrum coromandelianum (L.) Garcke	false mallow	X
Sida fallax Walp.	'ilima	I
Sida rhombifolia	Cuba jute	X
MENISPERMACEAE (Moonseed Family)		
Cocculus trilobus (Thunb.) DC.	huehue	I
MYOPORACEAE (False-sandalwood Family)		
Myoporum sandwicense A. Gray	naio, false sandalwood	I
MYRTACEAE (Myrtle Family)		
Metrosideros polymorpha Gaud.	'ohi'a lehua	E
Psidium guajava L.	guava	X
NYCTAGINACEAE (Four-o'-Clock Family)		
Boerhavia coccinea Mill.	--------	X
PAPAVERACEAE (Poppy Family)		
Argemone glauca (Nutt. ex Prain) Pope	pua kala	E
PASSIFLORACEAE (Passionflower Family)		
Passiflora edulis Sims	passionfruit, liliko'i	X
Passiflora foetida L.	love-in-a-mist	X
PHYTOLACCACEAE (Pokeweed Family)		
Rivina humilis L.	rouge plant	X
PIPERACAEAE (Pepper Family)		
Peperomia leptostachya Hooker & Arnott	'ala'ala-wai-nui	I
PORTULACACEAE (Purslane Family)		
Portulaca oleracea L.	common purslane	X
Portulaca pilosa L.	'ihi	X
Talinum triangulare (Jacq.) Willd.	talinum	X
PROTACEAE (Protea Family)		
Grevillea robusta A. Cunn. ex R. Br.	silk oak	X
ROSACEAE (Rose Family)		
Osteomeles anthyllidifolia (Sm.) Lindl.	'ulei	I

Species	Common Names	Status
RUBIACEAE (Coffee Family)		

Morinda citrifolia L.	Indian mulberry, noni	P
Psydrax odoratum (Forst. f.) A. C. Sm. & S. Darwin	alahe'e	I
SAPINDACEAE (Soapberry Family)		
Dodonaea viscosa Jacq.	'a'ali'i	I
SCROPHULARIACEAE (Snap-dragon Family)		
Lophospermum erubescens D. Don	larger roving sailor	X
SOLANACEAE (Nightshade Family)		
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato	X
STERCULIACEAE (Cacao Family)		
Waltheria indica L.	'uhaloa	I
VERBENACEAE (Verbena Family)		
Lantana camara L.	lantana	X
Stachytarpheta australis Moldenke	owi	X
Stachytarpheta cayennensis (Rich.) Vahl	blue rat's-tail	X

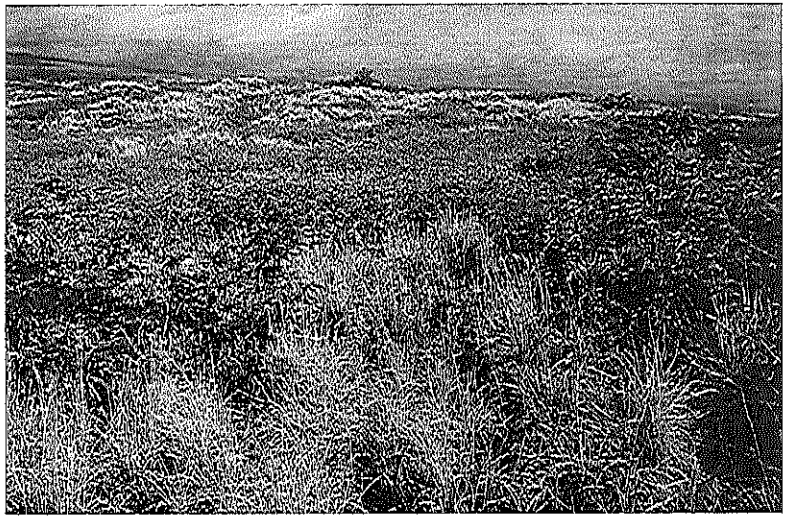

Fig. 3. *Leucaena* scrub at lower end of study site.

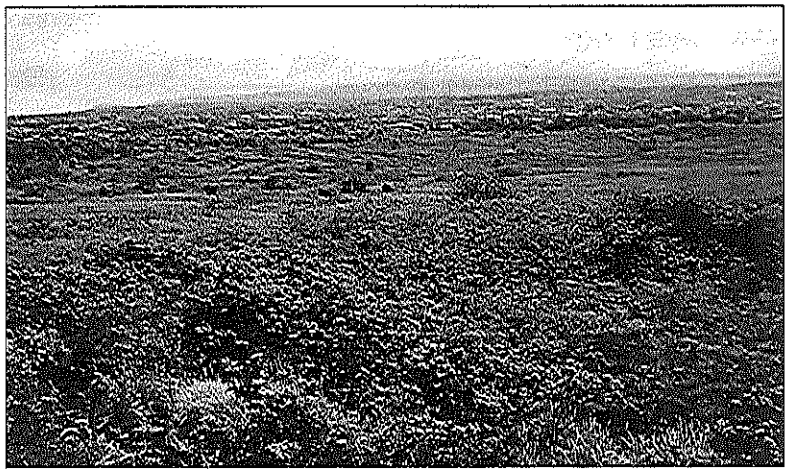

Fig. 4. *Leucaena* scrub on the north-central part of the study site.

Fig. 5. *Kalanchoë pinnata* dominating underneath a *Leucaena* canopy at north-central part of the site.

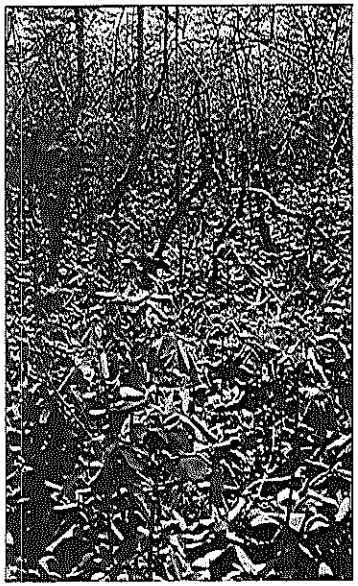

Fig. 6. Fountain grass growing under *Leucaena* trees.

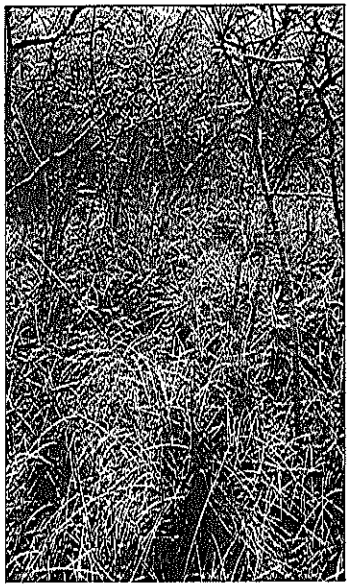

Fig. 7. Sparse Christmas-berry scrub at northeast corner of the study site.

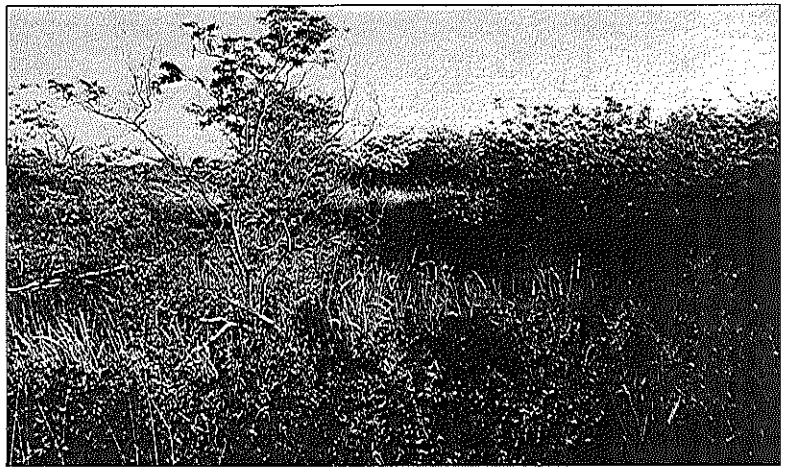

Fig. 8. Upper lava flow dominated by Christmas berry.

Fig. 9. Open lava in the dryland forest

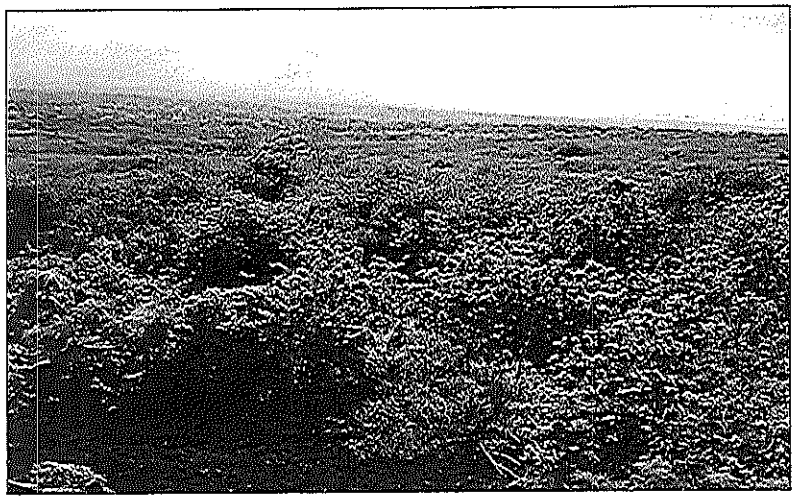

Fig. 10. Dense dryland forest.

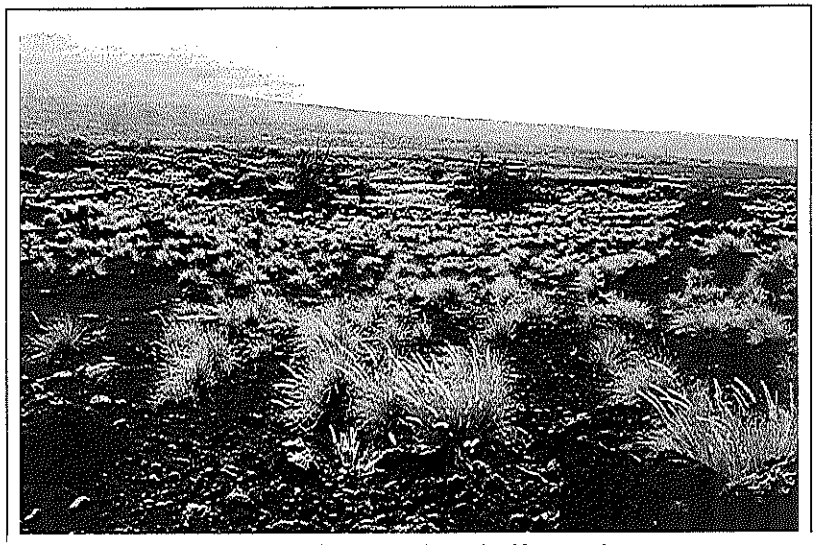

Fig. 11. Fountain grass coming up in old quarry site.

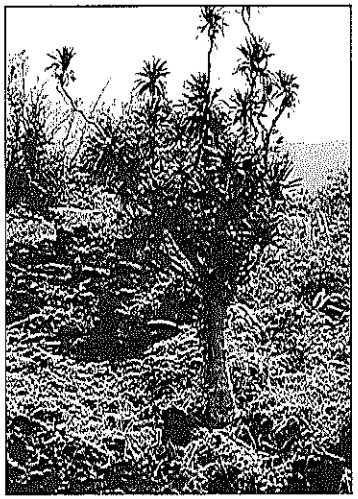

Fig. 12. *Pleomele hawaiiensis.*

Fig. 13. *Bidens micrantha* subsp. *ctenophylla.*

Appendix F

Kaloko Makai
Dryland Forest Preserve
Draft Habitat Conservation Plan
Ho‘okuleana, LLC
July 2011

KALOKO MAKAI
DRYLAND FOREST PRESERVE

DRAFT

HABITAT CONSERVATION PLAN

July 2011

Prepared by:

Ho`okuleana LLC

... to take responsibility ...

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Appendix D: A Survey of Avian and Terrestrial Mammalian Species on TMK (3) 7-3-09:17, 25, 26, and 28, at Kaloko, and Kohanaiki, North Kona District, Island of Hawai`i. David, Reginald. 2006.
Appendix E: Survey of Terrestrial Invertebrate Resources at Kaloko Makai, Kaloko and Kohanaiki, North Kona, Hawai`i Island. Montgomery, Steven L. PhD. 2008.

1.0 INTRODUCTION AND PROJECT OVERVIEW

1.1 Summary

SCD - TSA Kaloko Makai, LLC proposes to develop Kaloko Makai, a residential, mixed-use development, on approximately 1,142-acres of undeveloped land in Kaloko and Kohanaiki, North Kona, Hawai`i.

This Habitat Conservation Plan (HCP) addresses anticipated impacts to state and federal threatened, endangered and listed species from the construction of this development at Kaloko and Kohanaiki, North Kona, Hawai`i pursuant to Chapter 195D, Hawai`i Revised Statutes (HRS 195D).

Once construction of the Kaloko Makai development is complete, the development is not expected to result in take of additional listed species under HRS 195D.

As a separate, unrelated project, the Federal Highways Administration (FHWA) and the County of Hawai`i are constructing the Ane Keohokālole Highway between Kealakehe Parkway and Hina Lani Street. A portion of the highway cuts through the Kaloko Makai property, adjoining one side of the Kaloko Makai Dryland Forest Preserve. This highway project is separate from the Kaloko Makai project.

The U.S. Fish and Wildlife Service (USFWS) has begun an informal Section 7 consultation for the Ane Keohokālole Highway project with the FHWA and the County of Hawai`i. The proposed Ane Keohokālole Highway may affect the endangered and candidate species in the vicinity of Kaloko Makai.

Part of the informal Section 7 consultation process has been the drafting of conservation measures which the FHWA and the County of Hawai`i have agreed to implement. These conservation measures and associated funding are part of the management actions of this HCP.

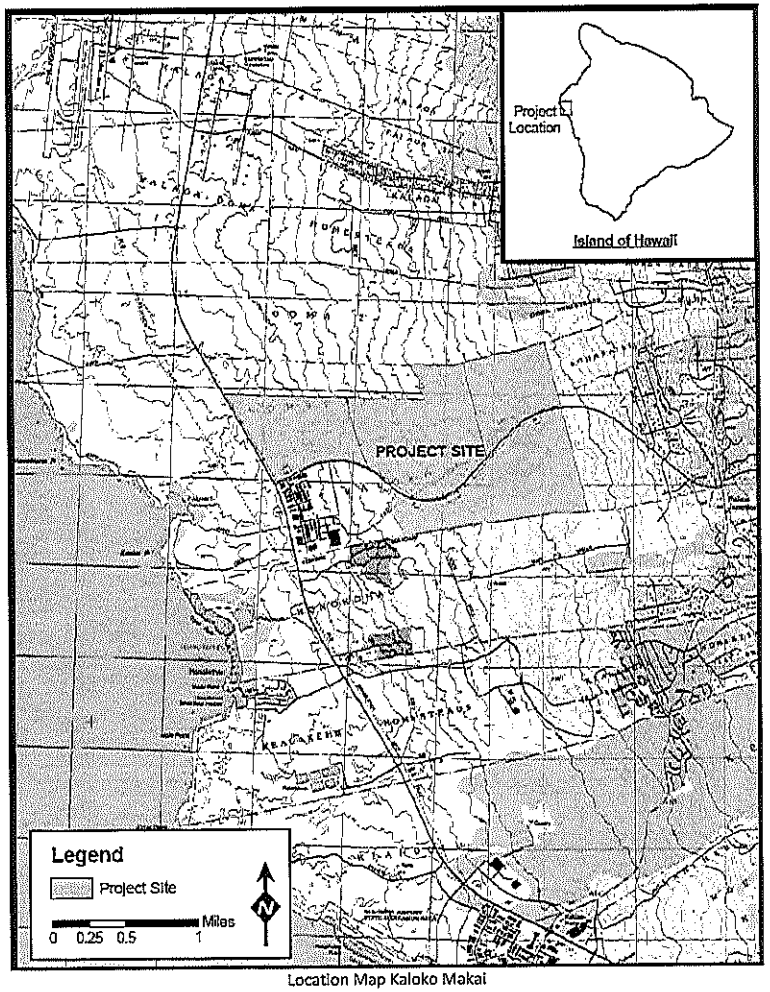
The species and habitat of the Kaloko Makai Dryland Forest Preserve will be best served by Kaloko Makai and FHWA working cooperatively to complement each other's management actions rather than to duplicate activities.

This HCP and proposed actions are subject to and dependent upon Kaloko Makai receiving all necessary entitlements and permits, and FHWA funding its proposed actions. If necessary entitlements, permits and FHWA funding its actions are not attained and the Kaloko Makai project is unable to move forward, the HCP and actions will not be implemented.

Kaloko Makai will be a master planned residential community with supporting commercial, light-industrial, educational, recreational, open space uses and their related infrastructure.

This diverse project will entail construction of up to 5,000-new single- and multi-family residential units at low- and medium-densities, centralized commercial and neighborhood retail centers, an array of recreational facilities (e.g. parks, trails, open spaces), urgent care medical facility and hospital, elementary and middle school sites and associated infrastructure (e.g., new roadways, utilities, drainage, wastewater and potable and non-potable water distribution systems).

The community development will satisfy a wide range of primary market housing needs, including the provision of affordable housing as required by the County of Hawai`i.



Location Map Kaloko Makai

1.1.1 Kaloko Makai HCP Focus, Success Criteria and Comparison with other Hawaii HCPs

Numerous Habitat Conservation Plans have been developed in Hawaii over the past few years.

Ultimately, as called for in State law, "All habitat conservation plans, safe harbor agreements, incidental take licenses, and subsequent actions authorized under those plans, agreements, and licenses shall be designed to result in an overall net gain in the recovery of Hawaii's threatened and endangered species." (HRS - 195D-30)

As noted by its name, the focus of the Habitat Conservation Plan addresses the "habitat" of the species to be protected. In the following, we discuss habitat concerns from negative and positive approaches. We end on the positive, as that is the goal of this HCP, a protection and preservation of the habitat.

As noted in the US Fish and Wildlife Service's (FWS) Endangered Species Bulletin, a simple question has a profound response: What factors drive plants to the point of needing Endangered Species Act (ESA) protection? Habitat destruction and modification are primary causes. (Progress in Plant Protection - J. Canfield)

FWS goes on to state, "Destruction, degradation and fragmentation of habitat is the driving force behind today's decline in species and biodiversity. Impacts to habitat can be caused directly by such activities as the clearing of forests to grow crops or build homes, or indirectly, for example, by the introduction of invasive species or increased pollution run-off from yards and fields. It is the mission of the U.S. Fish and Wildlife Service to work with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." (Progress in Plant Protection - J. Canfield)

On a positive perspective, "(H)abitat preservation is the most important element of most recovery plans". (esa.org)

With respect to State law, the statute notes: "The (habitat conservation) plan will further the purposes of this chapter by protecting, maintaining, restoring, or enhancing identified ecosystems, natural communities, or habitat types upon which endangered, threatened, proposed, or candidate species depend within the area covered by the plan". (HRS 195D-25(b)(1)(A))

This is consistent with federal law concerning HCPs, "Congress said that the purposes of the Act are "... to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved [and] to provide a program for the conservation of such . . . species. . . ." Habitat Conservation Plans (HCPs) under section 10(a)(1)(B) of the Act provide for partnerships with non-Federal parties to conserve the ecosystems upon which listed species depend, ultimately contributing to their recovery." (Habitat Conservation Plans Under the Endangered Species Act - fws.gov)

Likewise, as noted in the recently adopted DLNR Hawai'i Comprehensive Wildlife Conservation Strategy (CWCS), "(r)ecognizing the effectiveness of taking conservation actions at a habitat-level in addition to a species-specific level, the CWCS emphasizes threats to species and their habitats and conservation needs at three levels: statewide, island-wide, and taxa-specific." (CWCS)

"To address these threats, the CWCS identifies multiple strategies to implement the following seven priority conservation objectives for the State: (CWCS)

1) *Maintain, protect, manage, and restore native species and habitats in sufficient quantity and quality to allow native species to thrive;*
2) *Combat invasive species through a three-tiered approach combining prevention and interdiction, early detection and rapid response, and ongoing control or eradication;*
3) *Develop and implement programs to obtain, manage, and disseminate information needed to guide conservation management and recovery programs;*
4) *Strengthen existing and create new partnerships and cooperative efforts;*
5) *Expand and strengthen outreach and education to improve understanding of our native wildlife resources among the people of Hawai'i;*
6) *Support policy changes aimed at improving and protecting native species and habitats; and*
7) *Enhance funding opportunities to implement needed conservation actions"*

The Kaloko Makai HCP addresses and incorporates all of the strategies listed above, as noted in the underlined text emphasized above. The focus of the Kaloko Makai HCP is on habitat protection and management; invasive species management; through partnerships there are outreach and funding support and the species, those taken and others within the preserve, see opportunities for net gain and protection in perpetuity.

In looking at how other HCPs address threats and actions (a summary of prior Hawaii HCP's actions is listed below,) most have dealt with impacts to birds and bats. They have ranged from 3-30 years in overall term.

Anticipated "take" for these types of HCPs have ranged from 20 to over 400 individual birds and/or bats. Mitigation measures have involved protection and management of habitat, as well as outreach and best management practices. Propagation of species by the HCP applicants has not been called for by the HCP applicants; however, some of the applicants have provided funding for species reproduction.

There has been only one approved HCP that has covered listed plants. The "Habitat Conservation Plan for Abutilon Menziesii at Kapolei" was initiated by the State Department of Transportation for development of various parts of the city of Kapolei on Oahu. The take for the project involved the destruction of the entire Kapolei population of *Abutilon Menziesii* (estimated at 93 plants,) as well as the total destruction of the habitat.

Based on the mitigation measures and criteria for success found in other Hawaii HCPs, the Kaloko Makai HCP will be considered a success if:

- The number of plants that are propagated, planted and survive in the Preserve exceed the number of plants taken (representing a net gain for the species)
- Management measures make meaningful contributions toward addressing the major threats that habitat of the taken species face (major threats include development, fire, invasive species)

The combination of providing and preserving important habitat for the covered plant species, and addressing major threats to the habitat of listed species, combined with the very low level of anticipated take, means that the collection of mitigation measures described in this HCP will provide a substantial net benefit and gain to the listed plant species.

The overarching goal of on-site habitat management is to ensure that on-the-ground management actions, associated with maintaining habitat within the preserve, continue to provide habitat for the covered plant species.

Comparative Criteria of Other Hawaii HCPs

HCP	Existing Population	Anticipated Take	Term	Success Criteria
DOT Kapolei	93	All (93) (In addition, all of the habitat will be destroyed)	20 years	Short-Term: At least 25% survive for 2 years after irrigation is ceased; Recruitment of seedlings thru dry season; Seed production by at least 25% after irrigation is ceased. Long-Term: At least 240 adult plants are present averaged over a 5 year period after irrigation is ceased; Seedling recruitment is greater than mortality, averaged over a 5 year period after irrigation is ceased. Overall: 360 reproducing plants.
Cyanotech	84	20-30	3 years	Total number of birds fledged is greater than the total number of birds taken during the course of the permit.
Kaheawa I	8 (plus fly overs)	160	20 years	The actual take of the four listed species is less than or equal to the anticipated take; The project is making meaningful contributions toward the management and protection of the four target species that provide a net conservation benefit, i.e., are greater than the actual impacts, if any, experienced by each species as a result of the project.
Kaheawa II	8 (plus fly overs)	85 Baseline; 127 Higher	20 years	Mitigation efforts result in one more fledgling or adult than that required to compensate for the requested take of the required tier; Mitigation efforts will contribute to habitat and colony enhancement and the control of predator populations and thus will provide a net benefit to, and aid in the recovery of species.
Kahuku	9 (plus fly overs)	111 Baseline; 166 Higher	20 years	Mitigation efforts result in one more fledgling or adult than that required to compensate for the requested take of the required tier; Mitigation efforts will contribute to habitat and colony enhancement, and the control of predator populations and thus will provide a net benefit to, and aid in the recovery of, the two seabird species.
KIUC	Fly overs	645 Lethal; 275 Non-Lethal	5 years	Number of birds that are successfully released as a result of the KIUC-funded SOS Program exceed the requested take authorization; KIUC's SOS efforts under the HCP would contribute more birds to the species' Kaua'i populations than its facilities and activities are adversely affecting.
ATST	282	35	6-10 years	Mitigation efforts proposed should allow net recovery benefit requirements within a practical timeframe; Mitigation for the duration of the construction are likely to produce a net recovery benefit.
Kaua'i Lagoons	300 (plus fly overs)	418 Mortality; 330 Non-Lethal	30 years	Given the modest level of anticipated direct and indirect take and success of the measures implemented to date, the collection of mitigation measures will provide a substantial net benefit to Nēnē; The combination of providing and maintaining important habitat, and controlling predation, combined with the low level of anticipated take, means that implementation of the HCP will result in a significant net benefit to each of the covered waterbird species.

In addition, as is further described in this HCP, the Federal Highways Administration is involved with a new road construction that will impact endangered plans and their habitats in Kona. Kaloko Makai has cooperated with FWS and FHWA and has allowed FHWA to conduct mitigation and management measures to address actions that were the result of informal consultation between FWS and FHWA. The following is a summary of these actions:

Location	Existing Population	Anticipated Take	Term	Success Criteria
North Kona, Mid-level Road – informal consultation between FWS and FHWA	Unknown	Unknown	~3 years	Propagate and plant so that the following number survive in the dryland forest: 30 *Nothocestrum breviflorum*, 40 *Pleomele hawaiiensis*, 30 *Neraudia ovate*, 30 *Caesalpinia kavaiensis* and 40 *Bidens micrantha* ssp. *Ctenophylla*. FHWA will control weeds within a 15-ft. (5-m.) buffer around existing and planted species within the forest. Survival of individual plants equates to survival for at least three years, the third year without supplemental water. However, because of the harsh and variable conditions at the out-planting sites, USFWS's limited horticultural knowledge of these endangered and candidate plants and a scarcity of propagation material, an Implementation Team composed of Hawai'i Forestry Industry Association (HFIA) staff, USFWS staff and other botanists and horticulturalists familiar with dry forest restoration techniques, will be established in order to assist HFIA in adaptively managing the implementation of this project.

1.1.2 Actions and Measures of Success Criteria for Kaloko Makai HCP

After numerous and extensive surveys focused on identifying endangered species within the Kaloko Makai project, only two listed species (3 individual plants) and one candidate species (40 individual plants) were found outside of the dryland forest preserve. There are numerous endangered species within the dryland forest preserve. Proposed mitigation measures in the HCP include protection of habitat and management of threats to several endangered species including hala pepe, 'alea, ma'oloa and uhiuhi, as well as the candidate species ko'oko'olau.

1) Number of plants
   a. Propagating and planting three listed plants for every one taken (3-for-1)
   b. Survival of individual plants equates to survival for at least three years, the third year without supplemental water

2) Addressing threats
   a. Establishing dryland forest preserve in perpetuity, thereby protecting the habitat from development

b. Implementation of a fire plan, including development of water system within neighboring project, installation of a dip tank, setting aside land for County fire station, siting of lower risk land uses adjoining preserve, signage, etc
c. Weeding protocols, removing invasive species surrounding each endangered plant in the preserve

3) Term – 20 years (Kaloko Makai will continue management protocols initiated by FHWA for the *Nothocestrum breviflorum, Caesalpinia kavaiensis, Neraudia ovata* and *Pleomele hawaiiensis*, after the three-year FHWA management actions has expired and after land use entitlements are granted for the proposed development.)

4) Incidental Take License
As a result of this HCP and management measures, an Incidental Take License is requested for the take of all endangered species and candidate species that may be situated within the Kaloko Makai development area. Through this HCP applicant is applying for the issuance of an Incidental Take License by DLNR to enable the removal of all *Nothocestrum breviflorum, Pleomele hawaiiensis, Neraudia ovate, Caesalpinia kavaiensis* and *Bidens micrantha* ssp. *Ctenophylla* (if found) outside of the Kaloko Makai Dryland Forest Preserve, within the Kaloko Makai project.

The primary actions proposed in this HCP are summarized below:

Location	Existing Population*	Anticipated Take*	Term	Success Criteria
Kaloko Makai	2-hala pepe 1-'aiea 40-ko'oko'olau 0-ma'oloa 0-uhiuhi	2-hala pepe 1-'aiea 40-ko'oko'olau 0-ma'oloa 0-uhiuhi	20 years	Propagate and plant so that the following number survive in the dryland forest: 6-hala pepe. Continue management protocols initiated by FHWA for the 'aiea, hala pepe, ma'oloa and uhiuhi, within a 15-ft. (5-m.) buffer around existing and planted species within the forest. Survival of individual plants equates to survival for at least three years, the third year without supplemental water.

*Outside of the Kaloko Makai Dryland Forest Preserve

1.1.3 Basis Behind Integration of Management with FHWA

The reason we are not conducting management actions at the same time as FHWA is that essentially we would be duplicating efforts for the same plants, in the same location, at the same time, which is an unnecessary and wasteful expenditure of conservation management funds.

The reason we are following FHWA's management actions (after their approximate three years of management of the site,) is that FHWA is required to expend their funds (set aside for the Ane Keohokālole Highway project) by 2015 and are not able to spend any funds after that deadline. The species and habitat of the Kaloko Makai Dryland Forest Preserve will be best served by Kaloko Makai and FHWA working cooperatively to complement each other's management actions rather than to duplicate activities.

1.1.4 Alternatives

This HCP lists and details preferred management measures to provide a net gain in the species and provide appropriate mitigation measures for the protection of their habitat. In preparing this HCP, several alternative actions were also considered. A summary of these follows.

No Action Alternative
Under this alternative, no action would be taken in relation to habitat conservation or management. However, the development of Kaloko Makai would proceed as envisioned.

If development of the Kaloko Makai project does occur, two existing listed plants are currently located in the area of proposed development and without mitigation measures are at risk to be taken. The dryland forest would not be managed, major threats to the dryland forest would not be addressed and plants would not be propagated.

Ultimately, is the Kaloko Makai project does not move forward with development, this HCP will not be implemented. Thus, there would be little contribution to the recovery of the listed plant species.

This alternative was not selected because it would not meet the criteria of HRS 195D and Kaloko Makai would be at risk for violating prohibitions of the ESA as well as state law, HRS 195D.

Buffering Each Plant Alternative
Under this alternative, the development of Kaloko Makai would be modified to avoid the three listed plants which occur outside of the dryland forest and are within the proposed development area.

These three plants would remain in place and would be surrounded by a 50-foot buffer. A 50-foot buffer was selected because it is consistent with the Waiākea Forest Reserve management plan, which was approved by DOFAW and states "If threatened or endangered species are encountered ... a buffer zone of 50-feet of undisturbed vegetation will be fenced around the plant individual or population in question." This 50-foot buffer is also consistent with set back and buffer distances approved by the California Coastal Commission as setbacks where development adjoins habitat.

The buffers will protect the listed plants from activities in the area. The buffers would be landscaped and invasive species would be removed. However, the dryland forest preserve would not be managed, major threats to the dryland forest would not be addressed and no conservation actions would occur within the dryland forest.

This alternative was not selected because the chosen alternative provides a greater benefit to the listed species with the set aside and management of the dryland forest preserve.

Out Plant to Other Sites Alternative
Under this alternative, the development of Kaloko Makai would proceed as envisioned. Development would occur where two existing listed plants are currently located and these two plants would be a taken.

The dryland forest would not be managed, major threats to the dryland forest would not be addressed and no conservation actions would occur within the dryland forest.

Out-planting of the taken species, at a 3 for 1 ratio, would be conducted. However, out-planting would occur in other dryland forest management areas on the island of Hawai'i. Locations for out-planting could include dryland forests at La'i 'Ōpua, Palamanui, Ka'ūpūlehu and Pōhakuloa Training Area. This alternative was not chosen for a variety of reasons.

The alternative is not feasible because the above mentioned dryland forests are not under Kaloko Makai's ownership or control. This could prove problematic as Kaloko Makai would not be assured a commitment for access and implementation of management measures to its desired time frames.

There could also be conflicts in implementation of management measures with multiple parties doing the same type of management actions within the same area. Additionally, with management actions occurring elsewhere, there would be little contribution to the recovery of the listed plant species' Kaloko Makai dryland forest populations.

Fund Management Measures in other Dryland Forest Areas Alternative
Under this alternative, the development of Kaloko Makai would proceed as envisioned.

Development would occur where two listed existing plants are currently located and the two plants would be a taken. The dryland forest would not be managed, major threats to the dryland forest would not be addressed and no conservation actions would occur within the dryland forest.

Out-planting of the taken plants would not be conducted. Instead, Kaloko Makai would fund management and out-planting actions at other dryland forest management areas on the island of Hawai'i. Locations receiving funding could include dryland forests at La'i 'Ōpua, Palamanui, Ka'ūpūlehu and Pōhakuloa Training Area.

This alternative was not chosen because there would be no benefit to the Kaloko Makai dryland forest or the listed species populations contained within.

Kaloko Dryland Forest
The Kaloko Makai development is home to one of the largest remaining areas of dryland forest in the Hawaiian Islands. The Kaloko dryland forest is unique in that it has not been heavily impacted by ungulates, and therefore, has minimal impact from alien plant species. This area covers approximately 265-acres (crossing over several ownership boundaries) of an `a`ā lava flow that is much younger than the surrounding pāhoehoe flow.

Four endangered plant species, *Neraudia ovata* (ma`oloa), *Nothocestrum breviflorum* (`aiea), *Pleomele hawaiiensis* (hala pepe) and *Caesalpinia kavaiensis* (uhiuhi) and one candidate species *Bidens micrantha ssp. ctenophylla* (ko`oko`olau), are found within the dryland forest and are included in this HCP.

Neraudia ovata (ma`oloa) is a sprawling shrub in the nettle family (*Urticaceae*) that does not have stinging hairs. It is found in lowland and montane dryland forests. Previously known from the Kona coast from North Kona and Ka`ū, there is currently one known plant in Kaloko Makai. Alien plants such as Christmas berry, koa haole and fountain grass; habitat change due to volcanic activity; residential development; insects such as spiraling whitefly (*Aleurodicus dispersus)* and stochastic extinction and/or reduced reproductive vigor due to the small number of existing individuals are the major threats to this species.

Nothocestrum breviflorum (`aiea) is a stout tree in the tomato family (*Solanaceae*) with soft, sappy wood and dark brown bark. It is found in lowland and montane dryland forests. One known individual of this species occurs within Kaloko Makai. The threats to this species are cattle; the alien plants Christmas berry, fountain grass, lantana (*Lantana camara*), and koa haole (*Leucaena leucocephala*) and residential and recreational development.

Pleomele hawaiiensis (hala pepe) is a small, branching tree in the agave family (*Agavaceae*), with leaves spirally clustered at the tips of branches. It occurs in lowland dryland forests. Historically, it was found only on the island of Hawai`i, ranging from Hualālai to Ka`ū. Approximately 25-plants are currently known at Kaloko Makai. The threats to this species are habitat conversion associated with residential and recreational development; habitat destruction by cattle, pigs, sheep, and goats; fire (which destroyed a large portion of one Pu`u Wa`awa`a population in 1986); competition from alien plants such fountain grass, koa haole, Christmas berry, and lantana; habitat change due to volcanic activity and the lack of reproduction in all but two populations.

Caesalpinia kavaiensis (uhiuhi) is a member of the pea family (*Fabaceae*). It occurs in lowland dryland forests and the wood was traditionally used to make spears and daggers, as well as fishing lures. Its numbers have more recently declined as a result of grazing by introduced cattle, goats and sheep. One plant is found within Kaloko Makai.

Bidens micrantha ssp. ctenophylla (ko`oko`olau) is a tall, perennial herb in the aster family (*Asteraceae*) with bright yellow daisy-like flowering heads. This species is found only in dryland forests of the North Kona region. Plants typically germinate, flower and fruit during the rainy season (November through March), and live only a few years, dying during the dry season. There are about 415-individuals in Kaloko Makai. Ko`oko`olau are threatened by the alien plant species Christmas berry, fountain grass, and silk oak (*Grevillea robusta*); cattle and goats; fire and residential and commercial development. This species is a candidate for listing.

Kaloko Makai has determined that the Kaloko Makai project may cause the taking of two listed plant species (*Pleomele hawaiiensis* and *Nothocestrum breviflorum)* and one candidate species (*Bidens micrantha* spp. *ctenophylla)*. Likewise, through the informal Section 7 consultation between USFWS and FHWA these listed and candidate species are also in/near the Ane Keohokālole Highway project.

This HCP is designed to address the authorized take of these two listed species and one candidate species, as well as the preservation of two additional listed species (*Neraudia ovate* and *Caesalpinia kavaiensis)* of which no take is anticipated.

This HCP has been initiated to reduce threats to the Kaloko Makai populations of these five species and maintain their ecosystem. This document's primary purpose is to describe activities proposed to conserve these species through interim conservation measures. The separate FHWA actions and management measures are based on the construction of the Ane Keohokālole Highway and are not associated with the Kaloko Makai Project.

HRS 195D-4, states that any endangered or threatened species of land plant recognized by the Endangered Species Act (ESA) shall be so deemed under HRS 195D. The unauthorized "take" of such endangered or threatened species is prohibited (§195D-4(e)). The definition of "take" in Section 195D-2 is defined as follows:

"Take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect endangered or threatened species of aquatic life or wildlife, or to cut, collect, uproot, destroy, injure, or possess endangered or threatened species of aquatic life or land plants, or to attempt to engage in any such conduct."

The following is a summary of the take to be licensed by this HCP. All species occur on lands owned by Kaloko Makai; TMK (3) 7-3-009: 028.

Common Name	Scientific Name	Status	"Take" to be Licensed by HCP*
`alea	*Nothocestrum breviflorum*	endangered	1
hala pepe	*Pleomele hawaiiensis*	endangered	2
ma`oloa	*Neraudia ovata*	endangered	0
uhiuhi	*Caesalpinia kavaiensis*	endangered	0
ko`oko`olau (Bidens)	*Bidens micrantha* spp. *ctenophylla*	candidate species	40

* After numerous and extensive surveys focused on identifying endangered species within the Kaloko Makai project, only two listed species (3 individual plants) and one candidate species (40 individual plants) were found outside of the dryland forest preserve. There are numerous endangered species within the dryland forest preserve. Proposed mitigation measures in the HCP include protection of habitat and management of threats to several endangered species including hala pepe, 'alea, ma'oloa and uhiuhi, as well as the candidate species ko'oko'olau. As a result of this HCP and management measures, an Incidental Take License is requested for the take of all endangered species and candidate species that may be situated within the Kaloko Makai development area.

Kaloko Makai is working with the State of Hawai`i Department of Land and Natural Resources, Division of Forestry and Wildlife (DLNR-DOFAW) and the U. S. Fish & Wildlife Service (USFWS) because effects of the proposed development may affect listed species. The project also includes mitigation measures to achieve a net benefit for the listed species being disturbed.

This HCP for Kaloko Makai is written in anticipation of the issuance of an Incidental Take License (ITL) to cover the entire construction and integration period of the project, in addition to subsequent operations, for a total duration of 20-years. After 20-years, the HCP may be renewed, amended or extended if mitigation criteria are not met, up to 10-years for a total period of 30-years.

This HCP and proposed actions are dependent upon Kaloko Makai receiving all necessary entitlements and permits, and FHWA funding its proposed actions. If necessary entitlements, permits and FHWA funding its actions are not attained and the Kaloko Makai project is unable to move forward, the HCP and actions will not be implemented.

The County of Hawai`i and FHWA have committed to separate specific management actions through informal Section 7 Consultation with USFWS; these actions and associated funding are not part of the Kaloko Makai project, but are included in this HCP by reference. FHWA is not funding the Kaloko Makai actions and its involvement in the dryland forest is associated with the Ane Keohokālole Highway not the Kaloko Makai project.

Pursuant to HRS 195D, this HCP provides detailed descriptions of portions of the action along with detailed information outlining the avoidance, minimization, and implementation of mitigation measures

to achieve net recovery benefit. Analysis includes information that indicates this project may result in the "take" of the two listed plant species and one listed candidate species.

Information and documents used in analysis include: (1) Kaloko Makai September 2010, Environmental Assessment/Environmental Impact Statement Preparation Notice (EISPN) for Kaloko Makai, Kaloko and Kohanaiki, North Kona, Hawai`i; (2) Botanical Survey of Kaloko Properties, North Kona, Island of Hawai`i by Art Whistler, Ph.D., Isle Botanica, December 2006; (3) Survey of Avian and Terrestrial Mammalian Species at Kaloko and Kohanaiki, North Kona District, Island of Hawai`i by Reginald E. David, Rana Productions, Ltd., September 2006; (4) Survey of Terrestrial Invertebrate Resources at Kaloko Makai, Kaloko and Kohanaiki, North Kona, Hawai`i Island by Steven Lee Montgomery, November 2008; (5) Site inspection and plant survey of the Kaloko dryland forest conducted by the USFWS in March and May 2010; and (6) Information in our files and associated meeting notes.

1.2 Applicant Background

SCD - TSA Kaloko Makai, LLC proposes to develop Kaloko Makai, a residential, mixed-use development, on approximately 1,142-acres of undeveloped land in Kaloko and Kohanaiki, North Kona, Hawai`i.

The site is approximately 3-miles south of the Kona International Airport at Keahole and 3.5-miles north of the town of Kailua. The proposed project is situated on lands within the State Land Use Conservation, Agricultural and Urban Districts, necessitating a petition for State Land Use District Boundary Amendment. Reclassification of the Conservation and Agricultural Districts to the Urban District is being sought, and later a County of Hawai`i Zone Change and Project District.

The proposed project is identified as a Neighborhood Transit Oriented Development (TOD) in the Kona Community Development Plan (Kona CDP). Kaloko Makai will be a residential community, with supporting commercial, infrastructure, educational, recreational and open space uses. Kaloko Makai will include construction of up to 5,000-new single- and multi-family residential units at low-, medium-, and high-densities, centralized commercial and neighborhood centers, recreational facilities (e.g. parks, trails, open spaces), elementary and middle school sites and associated infrastructure (e.g., new roadways, utilities, drainage, wastewater and potable water distribution systems). Affordable housing will be provided in accordance with County of Hawai`i requirements.

Section 2.2 of this report provides more detailed information about the Kaloko Makai development.

1.3 Regulatory Context

The Applicant is seeking an Incidental Take License (ITL) in accordance with Chapter 195-D, Hawai`i Revised Statutes. This permit is issued by DLNR.

1.3.1 State Endangered Species Legislation (Chapter 195D, Hawai`i Revised Statutes)

Section 195D-4, HRS, states that any endangered or threatened species of aquatic life, wildlife and land plants recognized by the ESA shall be so deemed by state statute. The unauthorized "take" of such endangered or threatened species is prohibited (§195D-4(e)). The definition of "take" in Section 195D-2, HRS, mirrors the ESA definition. Under §195D-4(g), the Board of Land and Natural Resources (BLNR), after consultation with the Hawai`i State Endangered Species Recovery Committee (ESRC), may issue a temporary license (subsequently referred to as an "ITL") to allow take otherwise prohibited if the take is

incidental to the carrying out of an otherwise lawful activity. In order to qualify for an ITL, the following must occur:

- The applicant must submit and receive approval of an HCP;
- The applicant minimizes and mitigates the impacts of the take to the maximum extent practicable (i.e., implements an approved HCP);
- The applicant guarantees that adequate funding for the HCP will be provided;
- The applicant posts a bond, provides an irrevocable letter of credit, insurance, or surety bond, or provides other similar financial tools, including depositing a sum of money in the endangered species trust fund created by §195D-31, or provides other means approved by BLNR, adequate to ensure monitoring of the species by the state and to ensure that the applicant takes all actions necessary to minimize and mitigate the impacts of the take;
- Implementation of the HCP increases the likelihood that the species will survive and recover;
- The HCP takes into consideration the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed;
- The activity permitted and facilitated by the ITL does not involve the use of submerged lands, mining, or blasting;
- The cumulative impact of the activity, which is permitted and facilitated by the license, provides net environmental benefits; and
- The take is not likely to cause the loss of genetic representation of an affected population of any endangered, threatened, proposed, or candidate plant species.

Section 195D-4(i) directs DLNR to work cooperatively with federal agencies in concurrently processing HCPs, ITLs and ITPs. Section 195D-21 deals specifically with HCPs and its provisions are similar to those in federal regulations.

HCPs submitted in support of an ITL application must:

- Identify the geographic area encompassed by the plan; the ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan; and the endangered, threatened, proposed, and candidate species known or reasonably expected to be present in those ecosystems, natural communities, or habitat types in the plan area;
- Describe the activities contemplated to be undertaken within the plan area with sufficient detail to allow DLNR to evaluate the impact of the activities on the particular ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan;
- Identify the steps that will be taken to minimize and mitigate all negative impacts, including without limitation the impact of any authorized incidental take, with consideration of the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed; and the funding that will be available to implement those steps;

- Identify the measures or actions to be undertaken; a schedule for implementation of the measures or actions; and an adequate funding source to ensure that the actions or measures are undertaken in accordance with the schedule;
- Be consistent with the goals and objectives of any approved recovery plan for any endangered species or threatened species known or reasonably expected to occur in the ecosystems, natural communities, or habitat types in the plan area;
- Provide reasonable certainty that the ecosystems, natural communities, or habitat types will be maintained in the plan area, throughout the life of the plan;
- Contain objective, measurable goals; time frames within which the goals are to be achieved; provisions for monitoring; and provisions for evaluating progress in achieving the goals quantitatively and qualitatively; and
- Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals.

Section 195D-25 provides for the creation of the Endangered Species Recovery Committee (ESRC), which is composed of biological experts, representatives of relevant federal and state agencies (i.e., USFWS, DLNR), and appropriate governmental and non-governmental members to serve as a consultant to the DLNR and the Board of Land and Natural Resources (BLNR) on matters relating to endangered, threatened, proposed, and candidate species.

Duties of the ESRC include reviewing all applications for HCPs, Safe Harbor Agreements, and ITLs, and making recommendations to the DLNR and the BLNR on whether they should be approved, amended or rejected; reviewing all existing HCPs, Safe Harbor Agreements and ITLs annually to ensure compliance, and making recommendations for any necessary changes; and considering and recommending appropriate incentives to encourage landowners to voluntarily engage in efforts that restore and conserve endangered, threatened, proposed, and candidate species. The ESRC plays a significant role in the HCP planning process. The Applicant has met with the ESRC during the preparation of this draft HCP.

1.3.2 State Environmental Review: Chapter 343, Hawai'i Revised Statutes

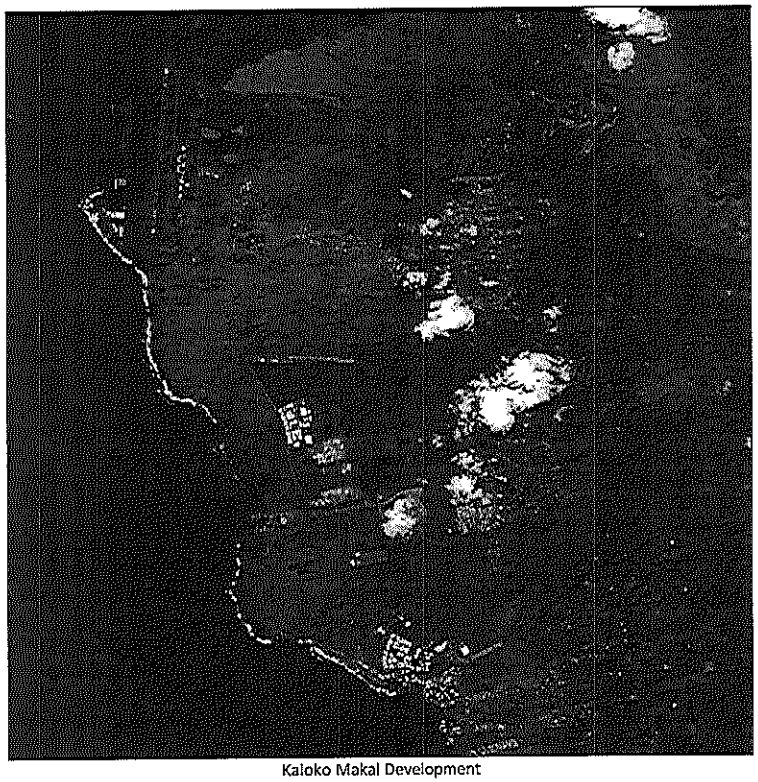
Chapter 343, Hawai'i Revised Statutes was developed to establish a system of environmental review, which will ensure that environmental concerns are given appropriate consideration in decision making along with economic and technical considerations (§343-1, HRS). Kaloko Makai will complete an EIS related to the project and is currently working on a draft EIS. Kaloko Makai will comply with Chapter 343 for any actions conducted under this Habitat Conservation Plan, as required by law.

2.0 PROJECT DESCRIPTION

2.1 Action Area/Geographic Area Encompassed by the Plan

The project site is located adjacent to and north/northeast of the existing Kaloko Industrial Park in the North Kona District on the Island of Hawai`i. The site is approximately 3-miles south of the Kona International Airport at Keahole and 3.5-miles north of the town of Kailua. It consists of approximately 1,142-acres and is identified by Tax Map Key: (3) 7-3-009: 017, 025, 026 and 028.

The site is located approximately one mile mauka of the coastline and lies between elevations ranging from approximately 100-feet above mean sea level (MSL) at the western end to 700-feet above MSL at the eastern end. Access to the site is from Queen Ka`ahumanu Highway and Hina Lani Street.



Kaloko Makai Development

2.2 Kaloko Makai Project Description

SCD - TSA Kaloko Makai, LLC proposes to develop Kaloko Makai, a residential, mixed-use development, on approximately 1,142-acres of undeveloped land in Kaloko and Kohanaiki, North Kona, Hawai`i.

The proposed project is situated on lands within the State Land Use Conservation, Agricultural, and Urban Districts, necessitating a petition for State Land Use District Boundary Amendment. Reclassification of the Conservation and Agricultural Districts to the Urban District is being sought, and later a County of Hawai`i Zone Change and Project District.

The proposed project is identified as a Neighborhood Transit Oriented Development (TOD) in the Kona Community Development Plan. Kaloko Makai is proposing a hospital site and is pursuing a Regional TOD designation. Kaloko Makai will be a residential community, with supporting commercial, infrastructure, educational, recreational and open space uses.

Kaloko Makai will include construction of up to 5,000 new single- and multi-family residential units at low-, medium-, and high-densities, centralized commercial and neighborhood centers, recreational facilities (e.g. parks, trails, open spaces), elementary school and middle school sites and associated infrastructure (e.g., new roadways, utilities, drainage, wastewater and potable water distribution systems). Affordable housing will be provided in accordance with County of Hawai`i requirements.

SCD-TSA Kaloko Makai, LLC seeks to instill a spirited sense of community throughout the 1,142-acre master planned community of Kaloko Makai. The mauka to makai orientation of the community will feature well-defined residential neighborhood villages, each village with its own distinct core of either retail and office, or parks and schools as a focus for nearby residents. Each neighborhood village will be woven together by a system of pedestrian scaled streets and trails connecting all of the villages to create one distinct community.

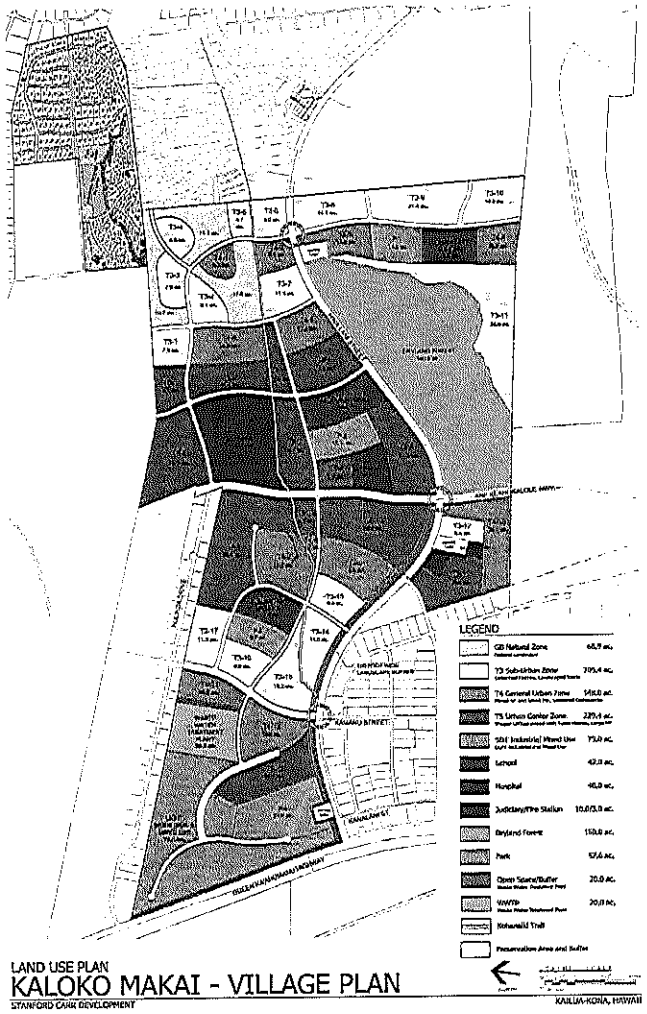
Diversity in residential land uses from single family residences to affordable multi-family homes will help to create living opportunities for everyone at Kaloko Makai. The project will define a regionally expressive, traditional Hawaiian architectural style which incorporates design elements that are human in scale, climatically appropriate and environmentally sensitive.

Tree-lined residential streets provide pedestrian connectivity to neighborhood commercial centers, 150-acre dryland forest preserve to the south, the neighborhood and community parks, the adjacent residential neighborhoods to the east and the natural trail system that winds throughout Kaloko Makai. Promoting connectivity will be one of the key design principles forming this unique place.

Much land has been set aside for parks to reinforce the natural wellbeing of the community. The open space framework forms the heart of this community and is conveniently located to all residents.

Preservation of resources, particularly the historic trails, adjacent and related archeological sites, primarily located in the northeastern portion of the property, play an important role in shaping the character of this distinct place.

Native Hawaiian beliefs, history, values and stories associated with these lands and the natural resources located within the trail's corridor will insure that this unique heritage will be respected and maintained.



Kaloko Makai Conceptual Land Use Map

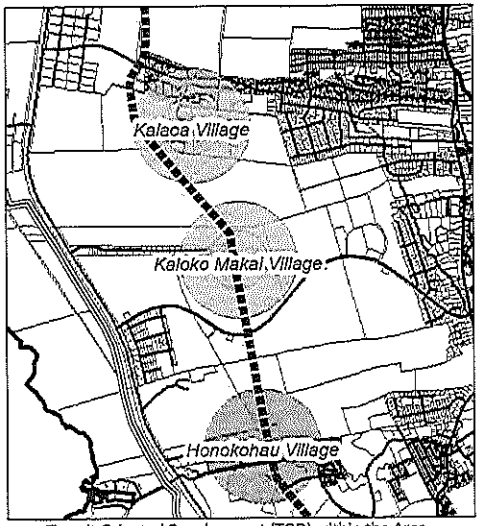
Kaloko Makai crafts distinctive neighborhoods, housing types, parks and preserved open space, as well as schools and gathering places that will make the community appealing to residents and visitors for years to come. The project endeavors to achieve the vision set forth by the Keahole to Kailua Development Plan more than 15-years ago, which designated the area to accommodate future urban growth and continues to be recognized for urban development as noted in the Kona CDP.

The Keāhole to Kailua Development Plan (K to K Plan) (1991) is an implementing tool for the Hawai'i County General Plan. The plan was adopted by the Hawai'i County Council to serve as a guide for development of infrastructure and land uses within the connection between Keāhole to Kailua, with recognition of the area for major future urban growth. According to the General Plan Amendment (December 2006), the project site is designated for Urban Expansion and Conservation.

In accordance with the Hawai'i County General Plan, community development plans are required to be adopted by the County Council for all judicial districts. The Kona CDP, adopted on September 25, 2008 (Hawai'i County Ordinance #08- 131), translates the broad General Plan Goals, Policies, and Standards into an implementation plan that applies to North and South Kona.

The Kona CDP addresses elements included in the General Plan such as transportation; land use; environmental resources; cultural resources; housing; public facilities, infrastructure, and services; energy; and economic development.

The Kona CDP identifies Kaloko Makai as a Neighborhood Transit Oriented Development (TOD). The TOD sites are proposed to consist of low-(T3, Sub-Urban), medium-(T4, General Urban), and high-(T5, Urban) density residential uses, as well as mixed-use commercial uses, centered around a transit hub along the proposed Ane Keohokālole Highway identified in the K to K Plan.



Transit Oriented Development (TOD) within the Area

The proposed project is identified as a Neighborhood Transit Oriented Development (TOD) in the Kona Community Development Plan. Kaloko Makai will be setting aside land for development of an urgent care medical facility, as well as land for a future hospital. A hospital developer/operator is being pursued. When a hospital commits to locating a hospital at Kaloko Makai, the TOD will automatically be designated as a Regional Center TOD.

Therefore, Kaloko Makai is being conceptually designed on the assumption that Kaloko Makai will be a Regional TOD.

Approximately 125-acres makai of the Kamanu Street extension will be established as light industrial, commercial, and retail area. This area of the project site is a natural extension of Kaloko Industrial Park located to the south of Kaloko Makai.

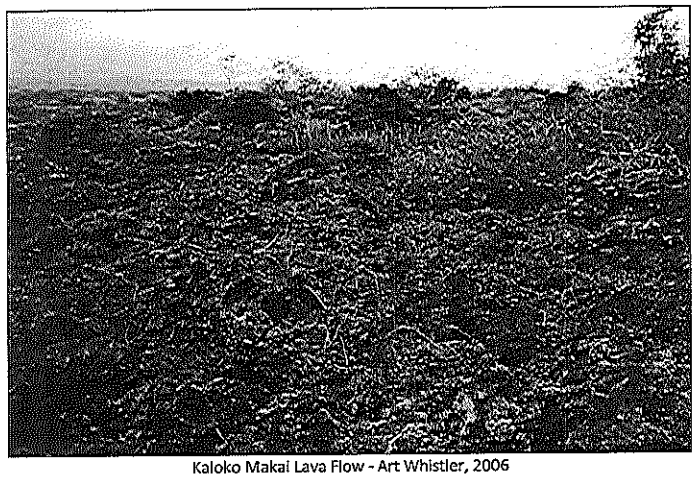
Kaloko Makai responds to the need for housing in North Kona. Currently, many residents who work in North Kona commute from outlying districts, such as Ocean View in Ka`ū. Housing is more affordable in these outlying areas, but the disadvantage is the long commute time. More housing is needed near centers of employment. The proposed development will help fulfill these housing needs, including affordable housing, for Kona.

2.3 Environmental Setting

2.3.1 Climate

The Kona region experiences a mild climate year-round. The average annual temperature is 75° (Fahrenheit), with an average high of 83°, and an average low of 67°. Median annual rainfall is approximately 25-inches, with areas along the coast experiencing less than 10-inches of rainfall annually.

The area is largely sheltered from the predominant northeasterly tradewinds by the land masses of Mauna Loa, Mauna Kea and Hualālai, resulting in light, variable winds. The prevailing winds are southerly and westerly. During the day, a pressure gradient between the warmer land and cooler ocean waters causes warm air to be moved inland by light sea breezes. In the evening, the convection cells reverse direction as the land cools and night breezes blow out toward the warmer ocean. Typical wind velocities range between 3 to 14-knots. Relative humidity is generally stable year-round, with the daily average ranging from 71 to 77%.



Kaloko Makai Lava Flow - Art Whistler, 2006

2.3.2 Topography and Geology

The project site occupies an area of relatively uniform slope, ranging from 5 to 8%. The lowest elevation along the makai boundary of the site is approximately 100-feet above mean sea level (MSL). Along the mauka boundary, the site reaches an elevation of about 700-feet above MSL. The site has a generally irregular surface with localized mounds and depressions throughout, as is characteristic of non-eroded lava flows.

The project site is located on the lower western slope of Hualālai, a dormant shield-type volcano. Hualālai Volcano last erupted in 1801 along its northwest rift zone, which represents the major geologic structure in the area. The western slopes of Hualālai Volcano consist predominantly of alkalic olivine basalt flows that poured out of the northwest rift zone. Basalt flows are typically thin-bedded, dip 10 to 15%, and average 4 or 5-feet in thickness on the upper slopes. These flows, however, probably average 10-feet in thickness on the more gentle (2%) slopes near the coast. The flows consist of both pāhoehoe and `a`ā types and belong to the prehistoric member (Holocene age) of the Hualālai volcanic series.

2.3.3 Soils

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) classifies the soil in the project site as pāhoehoe lava flows (rLW), a`ā lava flows (rLV), Kaimū extremely stone peat (rKED), and Punalu`u extremely rocky peat (rPYD). Lava flows are considered "miscellaneous land types". Pāhoehoe lava, which occurs over approximately 21% of the site, is characterized by a billowy, glassy surface that is relatively smooth, although the surface may be rough and broken in some areas, with hummocks and pressure domes.

Approximately 37% of the site consists of a`ā lava, which is characterized by clinkery, hard, glassy pieces piled in tumbling heaps. Both of these land types have no soil covering and are virtually devoid of vegetation. The lava is very slowly permeable, although water moves rapidly through the cracks. Runoff is slow and erosion hazard is slight. Approximately 6% and 36% of the project site consists of Kaimū and Punalu`u soils.

The soil capability class rating for both a`ā and pāhoehoe lava is Class VIII, indicating that the soils have severe limitations that make them unsuited for cultivation and commercial plants, and restrict their non-urban use largely to pasture, woodland, wildlife, water supply, and aesthetic purposes.

Punalu`u extremely rocky peat, 6 to 20% slope: These soils are comprised of rock outcrops over 40 to 50% of the surface, and medium-acid peat about 4-inches thick underlain by pāhoehoe lava bedrock. The peat is permeable. The pāhoehoe lava is very slowly permeable, although water moves rapidly through the cracks. Runoff is slow, and the erosion hazard is slight. These soils are rated Class VIIs soils, non-irrigated. Use of these soils is typically restricted to non-agricultural uses such as pasture or range land and nonagricultural uses. The sub-classification "s" indicates that the soils are extremely rocky or stony.

Kaimū extremely stony peat, 6 to 20% slope: These soils are comprised of very dark brown extremely stony peat about 3-inches thick. It is underlain by fragmental a`ā lava. This soil is neutral in reaction. Permeability is rapid, runoff is slow, and the erosion hazard is slight. This soil is not suitable for cultivation. These soils are also rated Class VIIs, non-irrigated.

The "Detailed Land Classification - Island of Hawai`i" prepared by the University of Hawai`i Land Study Bureau (LSB), evaluates the quality or productive capacity of certain lands on the island for selected crops and overall suitability in agricultural use. A five-class productivity rating system was established with "A" representing the highest productivity and "E" the lowest. Approximately 73% of the project area is rated E, the lowest productivity rating, approximately 9% is rated D, and the remaining is not classified.

The Agricultural Lands of Importance in the State of Hawai`i (ALISH) map, prepared by the State Department of Agriculture, classifies lands into three categories: 1) Prime Agricultural Land, which is land best suited for the production of crops because of its ability to sustain high yields with relatively little input and with the least damage to the environment; 2) Unique Agricultural Land, which is non-Prime agricultural land used for the production of specific high-value crops; and 3) Other Important Agricultural Land. Approximately 6% of the project site is designated "Other" and the remainder of the project site is not considered important agricultural lands.

2.3.4 Water

The natural drainage system of the project site consists of rainfall percolating through the layers of very porous lava to the ground-water table. There are no definable streams or natural drainage ways within or in the immediate vicinity of the site as the basaltic rocks of the substrata are highly permeable.

The surrounding area consists of barren a`ā and pāhoehoe lava fields which are highly permeable. The natural drainage pattern consists of rainfall percolating through layers of very porous lava to the subsurface strata.

In the vicinity of the project site, the only major drainage system is located along Queen Ka`ahumanu Highway. An existing culvert and headwall conveys runoff from mauka areas, underneath the Highway. The drainage system along Hina Lani Street consists of roadside swales and percolating dry wells which divert runoff from the roadway. There are no wetlands located within or in the immediate vicinity of the project site.

The Kaloko-Honokōhau National Historical Park, located makai of the project site along the coast and separated from the site by Queen Ka`ahumanu Highway, contains anchialine ponds (saltwater or brackish-water ponds) and wetlands. Two principal fishponds in the Park, the Kaloko and `Aimakapa fishponds, are large brackish ponds separated from the ocean by basaltic rock walls. These ponds are culturally significant as they are a prime example of traditional Hawaiian aquaculture. Water in these ponds is a mixture of seaward-flowing, low-salinity ground water and landward-flowing seawater. Wetland areas of approximately 15-acres exist adjacent to the `Aimakapa fishpond.

The project site overlies the Keauhou Ground-Water Aquifer System within the Hualālai aquifer sector. Ground water occurs beneath the project site as a thin, brackish to saline basal lens in hydraulic contact with seawater at depth and at the shoreline. However, further inland, along an alignment that is generally coincident with that of Māmalahoa Highway, there is a sudden change from the brackish basal lens to high-level ground water of exceptionally good quality. This transition in ground-water regimes, which was discovered in the early 1990s, extends from Kalaoa on the north end to Honaunau on the south end. Available hydrologic and geophysical evidence is generally consistent with the concept that the high ground-water levels are associated with a buried dike complex.

The anchialine ponds located within the Kaloko-Honokōhau National Historical Park makai of Queen Ka`ahumanu Highway lack a surface connection to the ocean, but are hydrologically connected to ground water and the ocean by a permeable aquifer. Numerous springs around the ponds supply the adjacent wetlands with brackish ground water.

2.3.5 Fauna

An avian and terrestrial mammalian species survey of the project site was conducted by Rana Productions in September 2006 (included as Appendix D). No avian species currently listed as endangered, threatened, or proposed for listing under either the federal or the State of Hawai`i's endangered species programs were observed during the course of the survey.

The indigenous Pacific Golden Plover (*Pluvialis fulva*) was observed during the survey. A number of other introduced birds including the Indian Gray Francolin, Common Myna, Japanese White-eye, House Finch, House Sparrow, Northern Cardinal and Java Sparrow are known to frequent the area.

Mammals such as the mongoose (*Herpestes auropunctatus*), European house mouse (*Mus domesticus*), goats (*Capra hircus*), pigs (*Sus scrofa*), and feral cats (*Felis catus*) were observed while on the project site.

Visual and electronic scans, using a Broadband AnaBat II® ultrasonic bat detector, were made for bats. The endangered `Ōpe`ape`a, Hawaiian hoary bat (*Lasiurus cinereus semotus*) was not detected during the survey.

It is likely that Hawaiian hoary bats over-fly the general project area on a seasonal basis; one Hawaiian hoary bat was detected as an incidental observation flying down-slope (*makai*) from above the eastern boundary of the site towards the ocean. This finding was not unexpected as bats are regularly seen *mauka* of the project site and also below the subject property in the Kaloko-Honokōhau National Historical Park and above the Honokōhau small boat harbor on a seasonal basis.

2.3.6 Invertebrate Resources

A survey of terrestrial invertebrate resources at Kaloko Makai was conducted by Steven Lee Montgomery in November 2008 (included as Appendix E). The survey found 12-invertebrates endemic to the Hawaiian Islands and 1-invertebrate indigenous to the Hawaiian Islands. No invertebrate currently listed as endangered or threatened under either federal or state statues was located within the survey area.

The survey team was alert for a variety of invertebrates on the property which were not found. No native snails were observed on the project property, nor were any Lava cricket (*Caconemobius anahulu*) found on site.

The study notes that the Kaloko Makai property does not provide appropriate habitat for any of the 12 native picture-winged flies (*Drosophila*) species recently listed as endangered or threatened. No native picture-winged flies were observed on the property.

The Blackburn's sphinx moth (*Manduca blackburni*), an endangered species was not found in this survey. The study also notes that neither the moth's native host plant, nor the best alien host, were observed on the property during the survey or during the most recent botanical survey by Whistler in 2006.

2.3.7 Flora

At least five botanical surveys in or adjacent to the area have been conducted in the past twenty years. The first was carried out in conjunction with a proposed transmission line that would have crossed the property (CH2M Hill 1993). The second survey was done for the Kaloko town center (site of the present business district, that includes Costco), which is adjacent to the current study site (Char and Associates 1995). In 2003, the USFWS sent a team for a reconnaissance of the site. The fourth was a botanical survey of the entire project site conducted by Isle Botanica in December 2006, for the Kaloko Makai development (included as Appendix C). Most recently in March and May 2010 the USFWS surveyed 264.5-acres around and including the Kaloko dryland forest.

The CH2M Hill botanical survey crossed the present study area, but also extended in either direction several miles, so the two areas are not exactly comparable. It listed the presence of 101-plant species in that corridor.

Three of the species recorded are federally listed endangered species. Five individuals of the sedge *Cyperus fauriei* (known at that time as *Mariscus fauriei*) were noted growing on a single boulder at about 115-m. elevation on the `a`ā flow. Two trees of *Nothocestrum breviflorum* were noted growing on the `a`ā flow at 110-m. elevation. Two mature individuals of *Neraudia ovata* were noted growing on the `a`ā lava flow at 115-m. elevation.

The checklist for the Char and Associates botanical survey on the property adjacent to the present study site listed a total of 47-species present, but none of these are federally listed.

The 2003, a USFWS survey team (USFWS 2003a & b) noted finding one live specimen of *Neraudia ovata* in the study area, and reported making "a sweep of the area looking for the other four known plants but found none of them. We suspect they may be dead."

They also noted the presence of good-sized individuals of *Bidens micrantha* spp. *ctenophylla* (ko`oko`olau) in low numbers and one dying *Pleomele hawaiiensis* (hala pepe) as well as several other native plant species.

In 2006, a botanical survey of the project site by Isle Botanica found a total of 93-plant species in the study area (no including a few cultivated species planted along the roadsides). Only one species found during the survey, *Pleomele hawaiiensis*, is a federally listed endangered species. The other three endangered plant species, *Cyperus fauriei*, *Nothocestrum breviflorum*, and *Neraudia ovata*, previously reported from the Kaloko dryland forest were not encountered during the survey.

In March and May 2010 the USFWS surveyed 264.5-acres around and including the Kaloko dryland forest. The survey team found four federally listed endangered species, `aiea (*Nothocestrum breviflorum*), ma`oloa (*Neraudia ovata*), hala pepe (*Pleomele hawaiiensis*), and uhiuhi (*Caesalpinia kavaiensis*). Additionally, ko`oko`olau (*Bidens micrantha* spp. *ctenophylla*) which is a candidate species for listing, was also present within the Kaloko dryland forest.

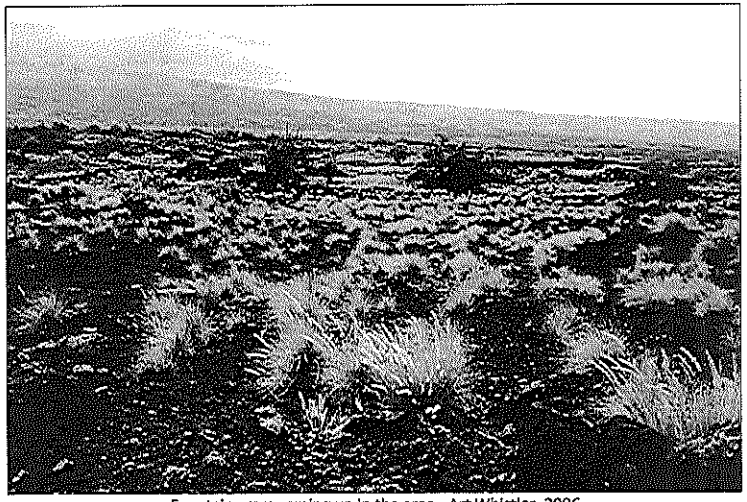
The survey recorded one `aiea (*Nothocestrum breviflorum*), one ma`oloa (*Neraudia ovata*), approximately twenty-five hala pepe (*Pleomele hawaiiensis*), one uhiuhi (*Caesalpinia kavaiensis*) and over 400 ko`oko`olau (*Bidens micrantha* spp. *ctenophylla*). *Cyperus fauriei*, previously reported within the Kaloko dryland forest was not encountered during the surveys.

Vegetation Types

The botanical survey of the project site by Isle Botanica in December 2006, identified four types of vegetation on the Kaloko property: (1) Managed Land Vegetation; (2) Leucaena Scrub, which can be divided into a lowland subtype with extensive amounts of *Pennisetum setaceum* between the trees, and an upland subtype with *Kalanchoe pinnata* and *Panicum maximum* dominating the ground cover; (3) Christmas Berry Scrub that occurs on recent `a`ā flows, and which can be divided into two subtypes, one with only scattered Christmas berry trees and a few native species, the other with a similar, denser, scrub forest; and (4) Dryland Forest.

Managed Land Vegetation

This comprises the areas of the parcel that are under periodic or frequent management, such as the edges of roads. It also includes the large quarry on the south side of the dryland forest. This is a relatively minor component of the overall vegetation on the property and is entirely dominated by alien weedy species, such as the grasses *Digitaria ciliaris* (large crabgrass) and *Rhynchelytrum repens* (Natal redtop), and the dicot herbs *Tridax procumbens* (coat buttons), *Chamaesyce hirta* (garden spurge), *Chamaesyce hyssopifolia*, *Desmodium tortuosum* (Florida beggarweed), *Macroptilium lathyroides* (cow pea), *Boerhavia coccinea*, *Waltheria indica* (`uhaloa, a native species) and *Sida rhombifolia* (Cuban jute).



Fountain grass coming up in the area - Art Whistler, 2006

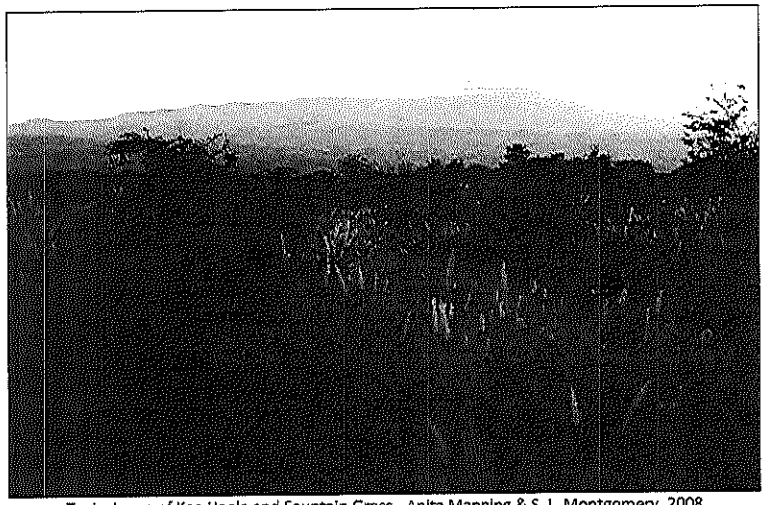
Leucaena Scrub

This is the type of vegetation found on areas of older lavas dominated by the alien scrubby tree *Leucaena leucocephala* (koa haole). It is not a homogeneous type of vegetation, since with increasing elevation along the north side of the road, its density and the species associated with it change.

On the lower portions, koa haole is mostly 1 to 2-m. in height, scattered in an open-to-dense matrix of *Pennisetum setaceum* (fountain grass).

Several other trees and shrubs are found here, but in low numbers. This includes the alien tree species *Prosopis pallida* (kiawe) and *Schinus terebinthifolius* (Christmas berry), the alien shrub *Acacia farnesiana* (kiu), the Polynesian introduction *Morinda citrifolia* (noni), and the native shrubs *Dodonaea viscosa* (`a`ali`i), *Psydrax odorata* (alahe`e), and *Sida fallax* (`ilima).

Also present are plants such as the shrubs *Indigofera suffruticosa* (indigo) and *Waltheria indica* (`uhaloa), the herbs *Chamaecrista nictitans* (lauki), *Talinum triangulare* and *Portulaca pilosa* (`ihi) and the grasses *Rhynchelytrum repens* (Natal redtop) and *Heteropogon contortus* (pili).

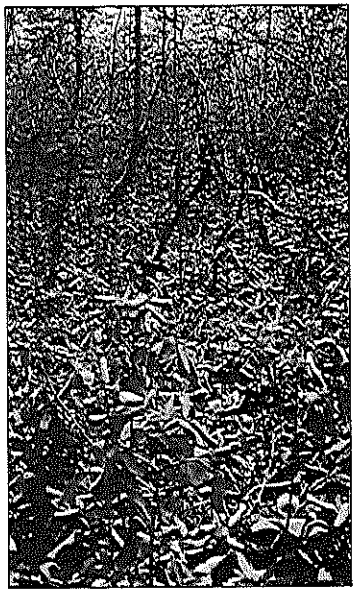


Typical area of Koa Haole and Fountain Grass - Anita Manning & S. L. Montgomery, 2008

This might be better described as mosaic vegetation, with patches of koa haole alternating with areas entirely dominated by the fountain grass, but this grass is also found in the partial shade of the koa haole, especially when its canopy is thin. It might equally validly be labeled as a fountain grass grassland with associated koa haole trees. At the upper (eastern or mauka) end of the property, the koa haole is also dominant, but is denser and taller (2 to 4-m. in height). Instead of forming a mosaic with fountain grass beneath, it forms a dense mono-dominant scrub forest.

Other tree species are interspersed with it, particularly the native trees or shrubs *Psydrax odorata* (alahe`e), *Diospyros sandwicensis* (lama), and *Sophora chrysophylla* (māmane), and the alien trees *Schinus terebinthifolius* (Christmas berry) and *Grevillea robusta* (silk oak). The latter two are large and scattered, but appear to be invasive and spreading.

The ground cover in this upper area is dominated by *Kalanchoe pinnata* (air plant) and *Panicum maximum* (Guinea grass), with some *Pennisetum setaceum* (fountain grass) in patches. The native herb *Peperomia leptostachya* (`ala`ala wai nui) is occasional on rocks.



Kalanchoe pinnata dominating underneath a *Leucaena* canopy (Art Whistler, 2006)

In disturbed areas across the road from this, next to the upper water tank, the Leucaena scrub has an understory of fountain grass. This differs from the lowland type of Leucaena scrub in that the trees are taller and more densely arranged.

Leucaena scrub is classified as disturbed, since fires periodically sweep through the area and goats are known to be present. These two factors account for the dominance of alien species, which are better adapted to these disruptive conditions than are the native species.

According to the flora of Hawai`i (Wagner et al. 1999), fountain grass "is rapidly expanding its range in the Kona district of Hawai`i." Introduced into the Kona District "in the early 1900s as an ornamental, [it] has aggressively spread and now dominates abandoned pastures, young lava flows, and burn areas.

Fountain grass poses one of the most serious contemporary conservation problems because it is disrupting the more sparsely vegetated lowland native dryland forests and shrub-lands, which contain several endangered and many candidate endangered plant species."

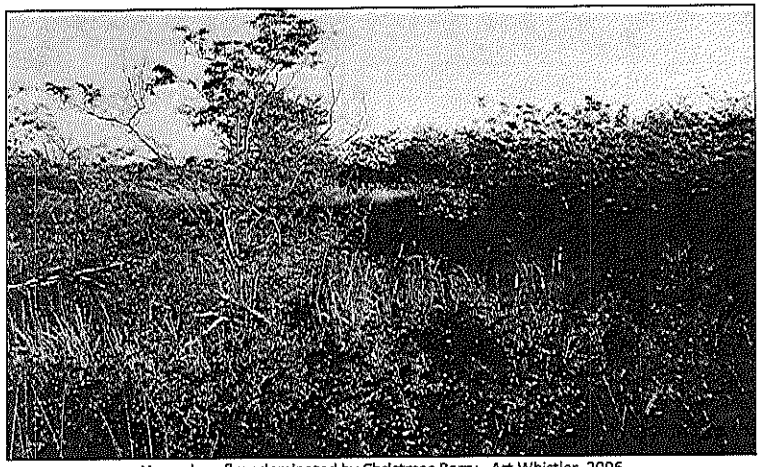
Christmas Berry Scrub

This is the type of vegetation on more recent lava flows, ones that are distinctly `a`ā lava. An irregular tongue of this runs down the slope near the northern boundary of the study site. In the lower portion of the study site, this vegetation is very sparse on the inhospitable surface, but scattered trees of the alien *Schinus terebinthifolius* (Christmas berry) comprise the most common species.

Also found here are scattered individuals of the native trees or shrubs *Capparis sandwichiana* (pua pilo), *Psydrax odoratum* (alahe`e), *Metrosideros polymorpha* (`ōhi'a lehua), *Myoporum sandwicense* (naio), as well as the introduced trees *Leucaena leucocephala* (koa haole) and *Morinda citrifolia* (noni).

The ground cover is also very sparse, with scattered clumps of *Pennisetum setaceum* (fountain grass) found mostly in pockets of soil or pāhoehoe, and perhaps being the most common species found here. There were also a few patches of *Ipomoea indica* (koali `awa) and *Cocculus trilobus* (huehue), and even smaller amounts of the alien species *Nephrolepis multiflora* (hairy sword fern), *Lantana camara* (lantana), and *Pluchea carolinensis*. Because the vegetation is so sparse, it hardly qualifies as vegetation at all, just scattered trees with equally scattered clumps of herbaceous species.

At higher elevations in this habitat on the same flow, where increasing rainfall and/or cloud cover makes the habitat more hospitable to trees, the vegetation comprises a low closed forest dominated by Christmas berry, with lesser amounts of the native trees *Psydrax odorata* (alahe`e), *Sophora chrysophylla* (māmane), and *Diospyros sandwicensis* (lama).



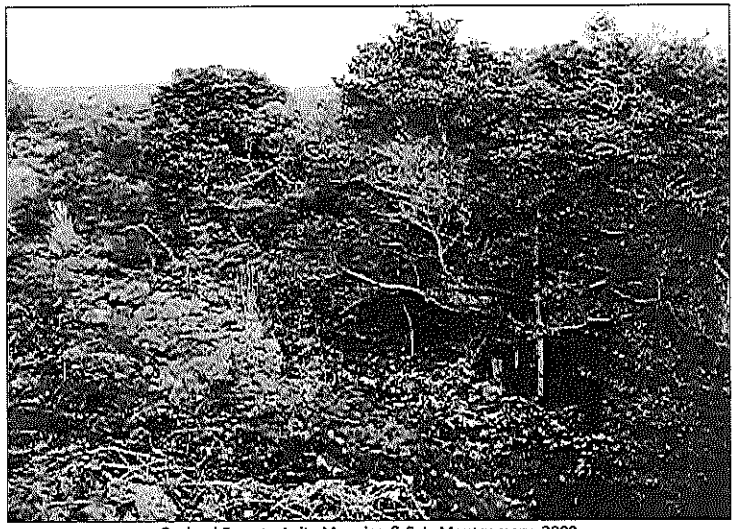
Upper lava flow dominated by Christmas Berry - Art Whistler, 2006

Tall individuals of *Grevillea robusta* (silk oak) are scattered in the area. The native shrub *Dodonaea viscosa* (`a`ali`i) is sometimes common in clearings on the lava. No individuals of *Metrosideros polymorpha* (`ōhi`a lehua), *Reynoldsia sandwicensis* (`ohe), *Pleomele hawaiiensis* (hala pepe), or *Myoporum sandwicensis* (naio) were found in this scrub forest. Because of the dense shade, very little ground cover is present, but that which is present comprises mostly *Panicum maximum* (Guinea grass) and *Kalanchoe pinnata* (air plant). However, some fountain grass is found in clumps on the lava flow there.

Like the *Leucaena* scrub, this vegetation is classified as disturbed, since fires periodically sweep through the area, and goats are known to be in the area. It somewhat matches the description of the "Lowland Dry Shrublands" described in Wagner et al. (1999), which is described as occurring in leeward situations on most of the main islands, at 100 to 600-m. elevation, and being open and not exceeding 3-m. in height. A majority of the project site is comprised of the two disturbed scrub vegetation and no federally listed endangered or threatened plant species were observed in the disturbed scrub areas.

Dryland Forest

The Kaloko dryland forest is located within the southern portion of the project site and is one of the last dryland forests still relatively free of introduced alien grasses and cattle. Dryland forests are the most impacted ecosystems in the Hawaiian Islands. While 42% of the rain forests in the Hawaiian Islands have been lost, 90% of the dryland forests have been eliminated. The remaining 10% has been heavily degraded by introduced plants and ungulates.



Dryland Forest - Anita Manning & S. L. Montgomery, 2008

The USFWS has long recognized the importance of the dryland forest on the site for its unique assemblage of native plants, and has indicated their desire to a preserve a portion of the property for its botanical value. The area has remained in such good condition because the substrate is a young lava flow that has acted as a deterrent to cattle, fire and the spread of alien grasses (USFWS pers. comm. 2006).

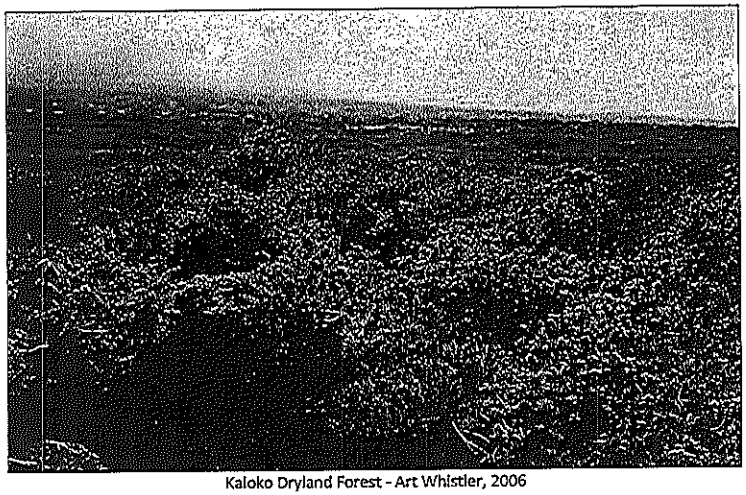
Because of the rugged `a`ā lava, the vegetation is difficult for feral grazing animals to visit. Over much of the area, the trees are separated from each other, and this, combined with the virtual absence of fountain grass, has caused the area to be spared from grazing and wildfires.

Consequently, the dryland forest is relatively intact, and was home until recently, at least, to four endangered species: *Nothocestrum breviflorum*, *Neraudia ovata*, *Cyperus fauriei*, and *Pleomele hawaiiensis*. The most common trees are probably the native species *Diospyros sandwicensis* (lama), *Psydrax odoratum* (alahe`e), *Capparis sandwichiana* (pua pilo), and *Sophora chrysophylla* (māmane).

Other native trees include, *Metrosideros polymorpha* (`ōhi`a lehua), *Reynoldsia sandwicensis* (`ohe), *Myoporum sandwicensis* (naio), and *Dodonaea viscosa* (`a`ali`i), as well as scattered individuals of the endangered tree-like monocot *Pleomele hawaiiensis* (hala pepe).

The only alien tree species noted in the Kaloko dryland forest were *Jacaranda mimosifolia* (jacaranda), the Polynesian introduction *Morinda citrifolia* (noni), *Schinus terebinthifolius* (Christmas berry), and *Leucaena leucocephala* (koa haole). The latter two species, especially Christmas berry, sometimes form clumps and in some places dominate the edges of the dryland forest.

The southern boundary of the Kaloko dryland forest has recently been bulldozed in quarry activities, and fountain grass is spreading in this newly created disturbed habitat.

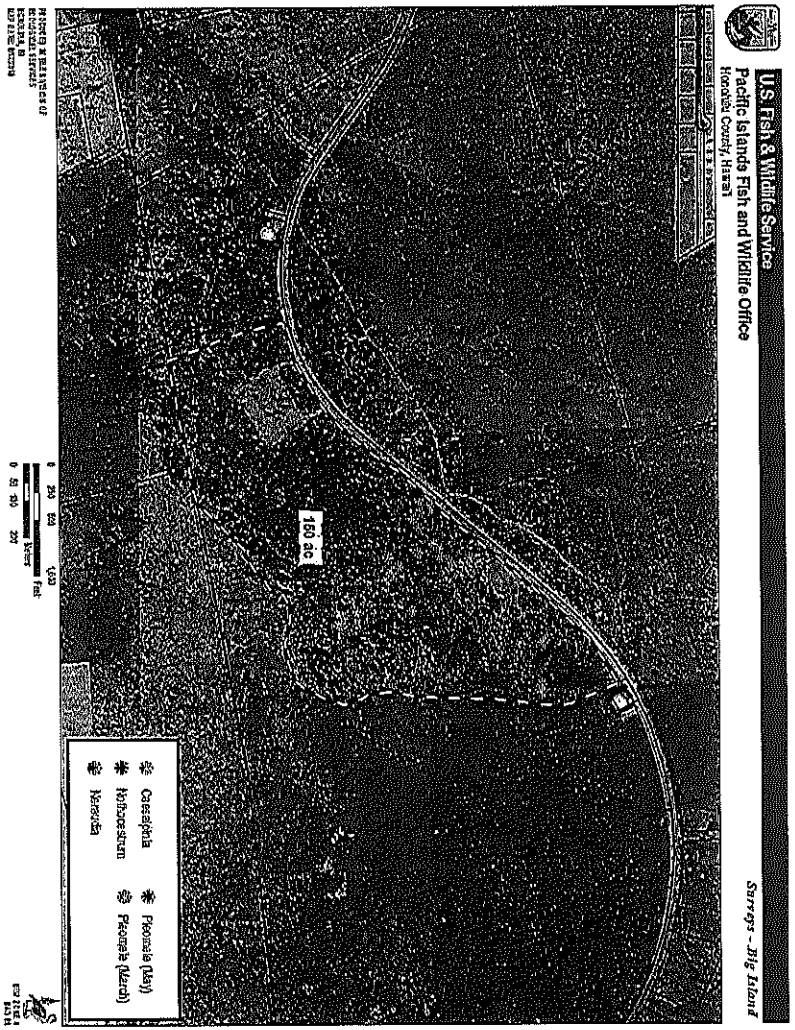


Kaloko Dryland Forest - Art Whistler, 2006

The ground cover in the dryland forest is very sparse, due to the inhospitable growing conditions. The most common species in this category are *Lantana camara* (lantana), the native vines *Cocculus trilobus* (huehue) and *Ipomoea indica* (koali `awa), *Pennisetum setaceum* (fountain grass), *Nephrolepis multiflora* (hairy sword fern), and an escaped ornamental vine *Lophospermum erubescens* (larger roving sailor).

Overall, this vegetation comprises a good quality dryland forest, based upon the flora and the dominance of native species. The native flora is virtually the same as that found in the list of the native flora on the whole site, with the possible exception of *Heteropogon contortus* (pili), which was found elsewhere on the Kaloko property but not in the Kaloko dryland forest.

A large portion of the Kaloko dryland forest will be protected within the Kaloko Makai Dryland Forest Preserve. Based on the USFWS review, delineation of the 150-acre Kaloko Makai Dryland Forest Preserve is noted in the following map.

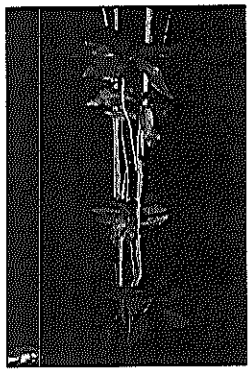


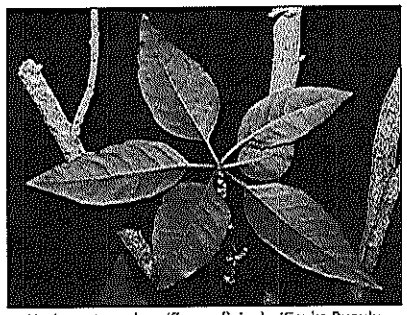
2.4 Species Description, Status and Baseline

2.4.1 *Nothocestrum breviflorum* (`aiea)

Species Description

Nothocestrum A. Gray is endemic to the main Hawaiian Islands. The genus comprises four species, two of which occur on the Big Island with one of these endemic to the Big Island. Both taxa on the Big Island are listed as endangered.





Nothocestrum breviflorum (`aiea) - Kīpuka Puaulu, Hawai`i Volcanoes NP - © 2006-2010 B. Rownd

Nothocestrum breviflorum is a stout tree 33- to 39-ft. (10 to 12-m.) tall (Symon 1990). The trunk, about 18-in. (45-cm.) in diameter, has a soft, sappy wood with dark brown bark. Oblong to elliptic, toothless, stalked leaves, 2 to 4.7-in. (5 to 12-cm.) long and 1.2 to 2.4-in. (3 to 6 cm.) wide, are generally confined to the ends of the branches and are seasonally shed.

In texture, they are relatively thick and papery. The upper leaf surface is glabrous (smooth) to sparsely whitish pubescent (downy), and the lower surface is often densely whitish pubescent.

Several to numerous flowers appear in clusters at the tips of shortened, spur-like branches. Each flower is subtended by its own stalk (pedicel) 0.2 to 0.4-in. (4 to 10-mm.) long. The 4-lobed, tube-shaped calyx, 0.2 to 0.4-in. (6 to 11-mm.) long, is split on one side. Green-yellow, 4-lobed petals are fused at the base and generally are enclosed in the calyx. The lobes are hairy on the outside. Fruits remain enclosed by the calyx and are orange-red, round berries about 0.2 to 0.3-in. (6 to 8-mm.) in diameter.

This species is distinguished from other Hawaiian members of the genus by leaf shape, number of flowers (more than three) in the flower clusters at tips of short spur-like branches, and the fruit remaining enclosed in the calyx (Symon 1990).

Nothocestrum breviflorum was first collected by Charles Pickering during the United States Exploring Expedition of 1840 and 1841. Based on these specimens, Asa Gray (1862) named the taxon *N. breviflorum*, thus referring to the short petals of the flower in this species.

Listing Status

Nothocestrum breviflorum (`aiea) is listed as Endangered. It was listed on March 4, 1994.

Historical Distribution

Nothocestrum breviflorum is known from the southern Kohala Mountains, the western, southern, and eastern slopes of Mauna Loa, and the northern slopes of Hualālai, Hawai`i.

Historic Distribution of *Nothocestrum breviflorum* (`aiea)

Locations	Number of Plants	Elevation	Ownership	Source	Date
S. Kohala, Kawaihae Iuka	Not Available (N/A)	N/A	N/A	N/A	N/A
Ka`ū, Kapāpala	N/A	N/A	N/A	Forbes	1911
Ka`ū, Hīlea Trail	N/A	N/A	N/A	Rock	1912
N. Kona	N/A	N/A	N/A	Cranwell	1938
Kīpuka Puaulu	1	N/A	Federal	N/A Fagerlund and Mitchell	1915 1943
S. Kona, Ki`liae	N/A	4,000 to 5,000-ft. (1,200 to 1,520-m.)	Private	N/A Baldwin	1944 1959
Kohala Mts., Waimea	N/A	2,400-ft. (730-m.)	Private	N/A Christensen	1926 1963
Nāulu	N/A	1,700 to 2,100-ft. (520 to 640-m.)	Federal	Newell	1966
N. Kona	2	1,000-ft. (300-m.)	State	Herbst	1970

Current Distribution

Since 1975, six populations have been identified on the western side of the Big Island from South Kohala to Kamāoa-Pu`u`eo (HHP 1991p1-12; Joel Lau, The Nature Conservancy of Hawai`i, pers. comm., 1992; W. Wagner, pers. comm., 1992; J. Giffin, pers. comm., 1995). Four populations consist of one to four plants each, and numbers are unknown for two populations. In addition, plants may have been cultivated at Kīpuka Puaulu for ornamental purposes (J. Giffin, pers. comm., 1995). The taxon has not been seen recently at Nāulu and is probably extirpated from that location (L. Pratt, pers. comm., 1995). Currently, there are fewer than 150 known individuals of this species in 10 populations (USFWS 2010).

Current Distribution of *Nothocestrum breviflorum* (`aiea)

Locations	Number of Plants	Elevation	Ownership	Source	Date
N. Kona Ka`ūpūlehu	4	2,000 to 2,200-ft. (607 to 670-m.)	Private	N/A Wagner *et al.* Lorence	1947 1983 1995
Ka`ū, Kamāoa-Pu`u`eo	1	600-ft. (180-m.)	State	N/A	1991
N. Kona, Pu`u Wa`awa`a	N/A	900 to 6,000-ft. (580 to 1,830-m.)	State	N/A Takeuchi and Tate	1909 1992
S. Kohala, Kīholo	N/A	N/A	N/A	N/A	1989 1992
N. Kona, Kaloko	2	360-ft. (110-m.)	N/A	HHP	1992
N. Kona, Kealakehe	1	260-ft. (79-m.)	N/A	HHP	1992

Habitat Description

Habitats of *Nothocestrum breviflorum* are lowland dryland forest, montane dry forest, and montane mesic forest dominated by *Metrosideros polymorpha, Acacia koa,* and/or *Diospyros sandwicensis.* Individuals occur on a`ā lava substrates at elevations ranging from 260 to 6,000-ft. (180 to 1,830-m.) (Gagne and Cuddihy 1990; Symon 1990; HELP 1991p1, 1991p5, 1991p7, 1991p12; NTBG 1991h).

Santalum lanaiense (`ilahi), *Caesalpinia kavaiensis* (uhiuhi), *Erythrina sandwicensis* (wiliwili) and several other taxa grow in association with *Nothocestrum breviflorum* (HHP 1991p1, 1991p3-p4, 1991p12; NTBG 1991h; W. Wagner, pers. comm., 1992; J. Giffin, pers. comm., 1995).

Threats

Nothocestrum breviflorum is negatively impacted by cattle and sheep grazing and by the introduction of alien plant taxa such as *Schinus terebinthifolius, Pennisetum setaceum* (fountain grass), *Lantana camara,* and *Leucaena leucocephala* (koa haole). The introduction of these invasive taxa may afford enough fuel to support a destructive fire.

Increased residential and recreational developments have reduced available habitat. Population and individual numbers of *Nothocestrum breviflorum* are few enough to face random extinction or reduced reproductive viability (HELP 1991p4, 1991p6, 1991p12; Lamb 1981; J. Giffin, pers. comm., 1995).

Environmental Baseline (Status of the Species in the Project Area)

One *Nothocestrum breviflorum* was found on the Kaloko Makai property by the USFWS in 2010. The plant is located just outside of the western edge of the dryland forest preserve.

The area where the *Nothocestrum breviflorum* is found is in the General Urban Zone of the project layout. The General Urban Zone will consist of village and neighborhood commercial uses with single family and multi-family residences with a density up to twelve units per acre.

Conservation Needs in the Action Area

The existing *Nothocestrum breviflorum* will remain in place, outside of the Kaloko Makai dryland forest preserve.

Using contractors to implement these actions, FWHA will establish a protective buffer around the existing *Nothocestrum breviflorum* with orange construction fencing during construction. FHWA will use best efforts to collect genetic material of *Nothocestrum breviflorum,* propagate and plant so that 30 individuals survive in the Kaloko Makai dryland forest preserve.

After construction, using contractors to implement these actions, Kaloko Makai will develop a 25-ft. (7.62-m.) buffer between the plant and any structure. The plant will be incorporated into landscaping within the 25-ft. buffer. Appropriate fencing will be incorporated into the landscaping to protect the plant.

For the first three years, FHWA will control weeds within a 15-ft. (5-m.) buffer around the existing *Nothocestrum breviflorum,* as well as the planted *Nothocestrum breviflorum* within the Kaloko Makai dryland forest preserve. Subsequently, Kaloko Makai will manage the weeding, as well as monitor the plants for insect damage and plant diseases.

2.4.2 *Pleomele hawaiiensis* (hala pepe)

Species Description

Pleomele hawaiiensis, of the agave family (*Agavaceae*), is a branching tree, 16 to 20-ft. (5 to 6-m.) tall, with leaves spirally clustered at the tips of branches, leaving large brown leaf scars as they fall off. The leaves measure 9 to 15-in. (23 to 38-cm.) long and 0.6 to 1-in. (1.4 to 2.7 cm.) wide. Flowers are numerous in terminal clusters with a main stalk 2 to 5-in. (6 to 13-cm.) long and individual flower stalks 0.2 to 0.5-in. (5 to 12-mm.) long. The three sepals and three petals of the flower are similar and pale yellow, 1.3 to 1.7-in. (33 to 43-mm.) long, with a constricted base.

The fruit is a red berry about 0.4 to 0.5-in. (10 to 13-mm.) long. This species differs from other Hawaiian species in this genus by its pale yellow flowers, the size of the flowers, the length of the constricted base of the flower and the width of the leaves (Degener and Degener 1930; St. John 1985; Wagner et al. 1990).

Pleomele hawaiiensis (hala pepe) - Kaloko Dryland Forest - Art Whistler, 2006

Otto and Isabelle Degener (1980) named *Pleomele hawaiiensis* from a specimen collected in 1977. Some experts considered this genus to be part of the larger genus *Dracaena,* but this combination is no longer used.

St. John distinguished two separate species, *P. haupukehuensis* and *P. konaensis;* however, the current treatment includes both in *Pleomele hawaiiensis* (Wagner *et al.* 1990).

Listing Status

Pleomele hawaiiensis (hala pepe) is listed as Endangered. It was listed October 10, 1996.

Historical Distribution

Historically, *Pleomele hawaiiensis* was found ranging from the Kohala Mountains to Ka`ū. (Degener and Degener 1980; HHP 1991h1-1991h8, 1993f1-1993f4; HPCC 1991g, 1992d, 1993b; St. John 1985; Tunison et al. 1991; Wagner et al. 1990).

Current Distribution

In 2006, nine populations were known on Federal, State, and privately owned land: one in the Kohala Mountains at Pu`u Kamoa (2-individuals); four from the Hualālai area with two populations in Pu`u Wa`awa`a (200-individuals and 50 to 100-individuals), one population in Ka`ūpūlehu (no information available), and one population in Kaloko (11-individuals); two populations in the South Kona area at

Manukā (no information available) and Kahuku (11-individuals); and two populations in Hawai'i Volcanoes National Park (no information on number of individuals for either population). These populations total 274 to 324-individuals. (Char 1987; HHP 1991h1, 1991h2, 1991h4, 1991h5, 1993f3, 1993f4; HPCC 1991g, 1992d, 1993b; Nagata 1984; Nishida 1993; Tunison et al. 1991; M. Bruegmann, in litt., 1994, 1996; W. Char, in litt., 1995; Samuel Gon III, HHP, in litt., 1992; J. Lau, in litt., 1990, 1993; L. Pratt, in litt., 1994; W. Char, pers. comm., 1994; Clyde Imada, Bishop Museum, pers. comm., 1994).

The only populations that are successfully reproducing are at Kaloko and Hōlei Pali in Hawai'i Volcanoes National Park (M. Bruegmann, in litt., 1994). An additional population may exist along the western boundary of Hawai'i Volcanoes National Park, but it has not been revisited recently (L. Pratt, in litt., 1995). Currently there are between 250 to 350 known individuals of this species in 6 to 8 populations (USFWS 2010).

Habitat Description

Pleomele hawaiiensis typically grows on open a'ā lava in diverse lowland dryland forests at elevations between 1,000 and 2,700-ft. (300 and 800-m.) (HHP 1991h1, 1991h2, 1991h4, 1991h5, 1993f3, 1993f4; HPCC 1991g, 1992d, 1993b; Wagner et al. 1990; S. Gon, in litt., 1992; J. Lau, in litts., 1990, 1993).

Associated taxa include 'ōhi'a, lama, māmane, *Psydrax odorata* (alahe'e), huehue, naio, Osmanthus sandwicensis (olopua), *Nototrichium sandwicense* (kulu'i), *Sida fallax* ('ilima), *Erythrina sandwicensis* (wiliwili), *Santalum lanaiense* ('iliahi), *Osteomeles anthyllidifolia* ('ūlei), and fountain grass as a dominant ground cover, as well as four federally endangered species: *Caesalpinia kavaiensis* (uhiuhi), *Colubrina oppositifolia* (kauila), *Nothocestrum breviflorum* ('aiea), *Neraudia ovata* (ma'oloa), and other species of concern, including *Capparis sandwichiana* (pua pilo) and *Bidens micrantha* ssp. *ctenophylla* (ko'oko'olau)(Char 1987; HHP 1991h2, 1991h4-1991h6; HPCC 1991g, 1992d, 1993b; M. Bruegmaun, in litt., 1994; S. Gon, in lift., 1992; J. Lau, in litts., 1990 and 1993).

Threats

The major threats to *Pleomele hawaiiensis* are habitat conversion associated with residential and recreational development; habitat destruction by cattle, pigs, sheep, and goats; fire; competition from alien plant taxa, such as fountain grass, koa haole, Christmas berry, and lantana; habitat change due to volcanic activity and the lack of reproduction in all but two populations (Char 1987; HHP 1991h2, 1991h4, 1991h5; HPCC 1991g, 1992d, 1993b; Nagata 1984; M. Bruegmann, in litt., 1994; J. Lau, in litt., 1990; C. Imada, pers. comm., 1994).

Environmental Baseline (Status of the Species in the Project Area)

The 2006 survey by Isle Botanica found approximately 24-plants on the Kaloko Makai property. At that time the USFWS noted that the Kaloko population was only one of two populations known to be successfully regenerating.

The USFWS survey in March of 2010 found approximately 23-plants within the dryland forest preserve. The USFWS survey in May of 2010 found approximately 22-plants within the dryland forest preserve. The same survey found 2-plants outside of the dryland forest preserve in both March and May.

The plants outside of the of the dryland forest preserve are found above Hina Lani Street to the north-west of the dryland forest border. This area is within the T-3 Sub-Urban transect zone (as called for in the Kona Community Development Plan and Village Design Guidelines) of the project layout. The T-3 Sub-Urban transect zone will consist of low density residential uses.

Conservation Needs in the Action Area

Two *Pleomele hawaiiensis* are found outside of the Kaloko Makai dryland forest preserve, on land that will be developed as part of the Kaloko Makai development.

Kaloko Makai, using contractors, will remove and transplant (where feasible) the two *Pleomele hawaiiensis* outside of the dryland forest preserve to the Kaloko Makai dryland forest preserve. The USFWS and DLNR-DOFAW will be consulted as to where the transplanting should occur within the Kaloko Makai dryland forest preserve.

The plants within the Kaloko Makai dryland forest preserve will remain in place.

Using contractors to implement these actions, FHWA will use best efforts to collect genetic material, propagate and plant *Pleomele hawaiiensis* so that 40-individuals survive in the Kaloko Makai dryland forest preserve.

Additionally, also using contractors to implement these actions, Kaloko Makai will use best efforts to collect genetic material, propagate and plant *Pleomele hawaiiensis* so that 6-individuals survive in the Kaloko Makai dryland forest preserve. The 6 individuals represent a 3-for-1 replacement of the 2 *Pleomele hawaiiensis* outside of the dryland forest preserve which will be disturbed. The USFWS and DLNR-DOFAW will be consulted as to where the plantings should occur within the Kaloko Makai dryland forest preserve.

For the first three years, FHWA will control weeds within a 15-ft. (5-m.) buffer around existing, transplanted and planted *Pleomele hawaiiensis* within the Kaloko Makai dryland forest preserve. Subsequently, Kaloko Makai will manage the weeding, as well as monitor the plants for insect damage and plant diseases.

2.4.3 *Neraudia ovata* (ma'oloa)

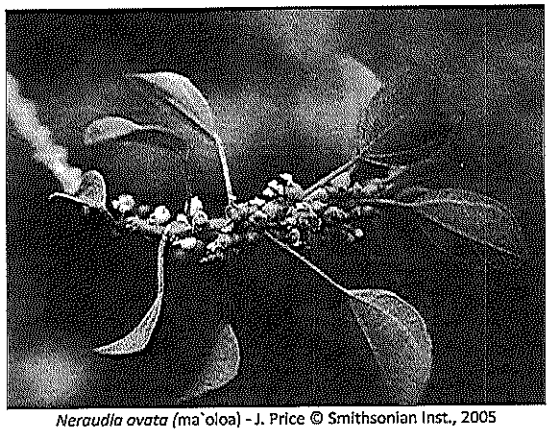
Species Description

Neraudia ovata, of the nettle family (*Urticaceae*), is a sprawling or rarely erect shrub to a small tree, with stems 3 to 10-ft. (1 to 3-m.) long, and branches bearing short, somewhat erect hairs. The alternate, thin, stalked leaves are smooth-margined, grayish on the undersurface, 2 to 5.5-in. (5 to 14-cm.) long and 0.8 to 2.6-in. (2 to 6.5-cm.) wide, and have spreading, curved, nearly translucent hairs. Male and female flowers are found on separate plants. Male flowers have extremely short stalks and a densely hairy calyx. Female flowers have no stalks and a densely hairy, boat-shaped calyx. The fruit is an achene (a dry, one-seeded fruit that does not open at maturity). This species is distinguished from others in this endemic Hawaiian genus by the density, length, and posture of the hairs on the lower leaf surface; smooth leaf margin; and the boat-shaped calyx of the female flower (Cowan 1949; Wagner et al. 1990).

The first name applied to this plant was *Neraudia pyrifolia*, by Charles Gaudichaud-Beaupre, based on material he collected in the early 1800s on the island of Hawai'i (Cowan 1949). This name was later determined to have been invalidly published, lacking an adequate description. Gaudichaud-Beaupre applied the name *Neraudia ovata* to another specimen of what is now considered to be the same species, and this name is used in the current taxonomic treatment. H. A. Weddell considered this taxon a variety of *Neraudia melastomifolia*, but this has not been upheld by other taxonomists. S. L. Endlicher and E. G. Steudel placed this species in the genus *Boehmeria*, but the current taxonomic treatment maintains *Neraudia* as an endemic Hawaiian genus.

Harold St. John named a new species, *Neraudia cookii*, from a collection by David Nelson on Cook's 1779 voyage to Hawai'i (St. John 1976). That specimen is considered to belong to *Neraudia ovata* in the current taxonomic treatment (Cowan 1949; Wagner et al. 1990).

Listing Status
Neraudia ovata (ma'oloa) is listed as Endangered. It was listed October 10, 1996.



Neraudia ovata (ma'oloa) - J. Price © Smithsonian Inst., 2005

Historical and Current Distribution
Historically, *Neraudia ovata* was found from North Kona all the way to Ka'ū (Cowan 1949; HHP 1991d1-1991d3, 1993d1-1993d7; Hillebrand 1888; St. John 1976 and 1981; Skottsberg 1944).

Three extant known populations have been documented including the Kaloko population.

The second population of 8-individuals was surveyed in late 1995 and again in 1997 by Colorado State University personnel. This population is located at the boundary of the U.S. Army's Pōhakuloa Training Area (PTA) and Pu'u Anahulu, owned by the State (Shaw et. al. 1997; HHP 1993d4, 1993d5; M. Bruegmann, in litt. 1996, 1997, pers. comm. 1997).

The third population, which is located within PTA, has not been surveyed since 1980. It is unknown how many plants occur at this site.

Currently there are approximately 125 individuals of this species in 5 populations (USFWS 2010).

Habitat Description
Neraudia ovata grows in open 'ōhi'a and māmane dominated lowland and montane dry forests at elevations of 380-ft. (115-m.) at Kaloko and 4,350 to 5,000-ft. (1,325 and 1,520-m.) at Pōhakuloa Training Area (HHP 1993d4, 1993d5; Nishida 1993; M. Bruegmann, in litt., 1994, 1996; R. Shaw, in litt. 1996).

Associated taxa include *Reynoldsia sandwicensis* ('ohe), nalo, *Cocculus trilobus* (huehue), *Myrsine* lessertiana (kōlea lau nui), and *Schinus terebinthifolius* (Christmas berry), as well as the federally endangered *Nothocestrum breviflorum* ('alea) and *Pleomele hawaiiensis* (hala pepe), and other species of concern, including *Capparis sandwichiana* (pua pilo), *Fimbristylis hawaiiensis*, and *Bidens micrantha* ssp. *ctenophylla* (ko'oko'olau) (Nishida 1993; Warshauer and Gerrish 1993; M. Bruegmann, in litt., 1994, 1996).

Threats
The major threats to *Neraudia ovata* are heavy browsing and habitat modification by feral sheep and goats *(Capra hircus)*; competition from alien plants such as Christmas berry, *Leucaena leucocephala* (koa haole), and *Pennisetum setaceum* (fountain grass); habitat change due to volcanic activity; residential development; insect damage by the non-native spiraling whitefly *(Aleurodicus dispersus)*; and a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing individuals in the three remaining populations (Nishida 1993; M. Bruegmann, in litt., 1994, 1996).

The State of Hawai'i Department of Agriculture (DOA) has conducted a very successful bio-control program for the spiraling whitefly which has significantly reduced damage caused by this insect (M. Isherwood, Jr., pers. comm. 1997). The spiraling whitefly remains a problem on certain preferred host plants, particularly in the summer, or on windy coastal areas where bio-control efforts are not effective.

Environmental Baseline (Status of the Species in the Project Area)
One *Neraudia ovate* plant was found within the dryland forest preserve during the USFWS survey in March/May of 2010.

Conservation Needs in the Action Area
The existing plant within the Kaloko Makai dryland forest preserve will remain in place.

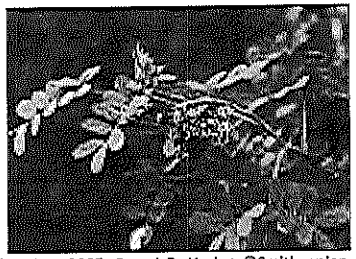
Using contractors to implement these actions, FHWA will use best efforts to collect genetic material, propagate and plant *Neraudia ovate* so that 30-individuals survive in the Kaloko Makai dryland forest preserve.

For the first three years, FHWA will control weeds within a 15-ft. (5-m.) buffer around the existing and planted *Pleomele hawaiiensis* within the Kaloko Makai dryland forest preserve. Subsequently, Kaloko Makai will manage the weeding, as well as monitor the plants for insect damage and plant diseases.

2.4.4 *Caesalpinia kavaiensis* (uhiuhi)

Species Description
Caesalpinia kavaiensis, a member of the pea family (*Fabaceae*), is a tree that can grow up to 33-ft. (10-m.) tall, with trunks that have dark gray bark with rough rectangular or oblong plates. The leaves are pinnate, having 4 to 8-leaflets about 1.25-in. (3-cm.) in length. The flowers are perfect (with both male and female organs) with a pink to rose calyx and red anthers borne in terminal racemes that are pink to red in color. Seed pods are flat, very thin, bluish-glaucous when young, and pale pink to gray when older. They are about 3.2-in. (8-cm.) long and 2-in. (5-cm.) wide, with a conspicuous line running down the length of the pod.

The wood of *Caesalpinia kavaiensis* is highly valued for its color, grain and density. Hawaiians made spears and fishing lures with the wood. The past cutting of trees for these uses is likely not the contributing factor to its decline and current endangered status, as numbers have more recently declined as a result of grazing by introduced cattle, goats and sheep. *Caesalpinia kavaiensis* plants, both wild and cultivated produce viable seed. Seeds of *Caesalpinia kavaiensis* have been tested by the Center for Conservation Research and Training, finding that they are orthodox and can tolerate freezing and drying. The laboratory germination time was one to three weeks.



Caesalpinia kavaiensis (uhiuhi) - W. L. Wagner ©Smithsonian, 2005; Derral R. Herbst ©Smithsonian, 2005

Listing Status
Caesalpinia kavaiensis (uhiuhi) is listed as Endangered. It was listed on October 24, 1996.

Historical Distribution
Caesalpinia kavaiensis, an endemic Hawaiian tree species, was once widespread on the islands of Kaua`i, O`ahu, west Maui, Lāna`i, and the North Kona District of Hawai`i. It occurred throughout dry forest ecosystems, ranging in elevation from 250-ft. to 3,000-ft. (78-m. to 910-m.)

Current Distribution
Caesalpinia kavaiensis is now extinct on Kaua`i, Lāna'i, and Maui and is found only on O`ahu in the Wai`anae range, and on the island of Hawai`i on the slopes of Mt. Hualālai.

Eight subpopulations are known, totaling 50-individuals; however, many of these are probably non-reproductive due to various problems.

Less than 20-individuals total are found in two populations on the island of Hawai`i. Less than 10-individuals total remain in the two populations on O`ahu. The last remaining individual in Waimea Canyon (Po`omau) died in 1992, as a result of hurricane `Iniki.

The Hawai`i population occurs on the Pu`u Wa`awa`a Ranch, State-owned land, and on private land. Many of these habitats have been devastated by development, livestock grazing, fire and invasion by aggressive alien plant species.

Currently there are approximately 50 individuals of this species in 8 populations remaining (USFWS 2010).

Habitat Description
Caesalpinia kavaiensis is restricted to dryland or mesic forests between 262 to 3,018-ft. (80 to 920-m.) elevations. Associated native species include *Dodonaea viscosa* (a`ali`i), *Diospyros sandwicense* (lama), *Metrosideros polymorpha* (`ōhi`a), *Psydrax odorata* (alahe`e), *Erythrina sandwicensis* (wiliwili), *Chenopodium oahuense* (`aheahea), and *Colubrina oppositifolia* (kauwila).

Threats
On the island of Hawai`i, the dryland forest habitats have been altered severely through invasion by *Pennisetum setaceum* (fountain grass), which forms dense monotypic cover throughout large areas, inhibiting seedling recruitment and vastly increasing the risk of fires.

Recently, fireweed (*Senecio madagascariensis*) has become established and is increasing in density and frequency throughout the area. Additionally, development; goats; pigs; seed predation by rats; black twig borer and collection of seed by unauthorized individuals have become threats as well.

Environmental Baseline (Status of the Species in the Project Area)
One *Caesalpinia kavaiensis* plant was found within the dryland forest preserve during the USFWS survey in March/May of 2010.

Conservation Needs in the Action Area
The *Caesalpinia kavaiensis* will remain in place within the Kaloko Makai dryland forest preserve.

Using contractors to implement these actions, FHWA will use best efforts to collect genetic material, propagate and plant *Caesalpinia kavaiensis* so that 30-individuals survive in the Kaloko Makai dryland forest preserve.

For the first three years, FHWA will control weeds within a 15-ft. (5-m.) buffer around the existing and planted *Caesalpinia kavaiensis* within the Kaloko Makai dryland forest preserve. Subsequently, Kaloko Makai will manage the weeding, as well as monitor the plants for insect damage and plant diseases.

2.4.5 *Bidens micrantha spp. ctenophylla* (ko`oko`olau)

Species Description
Bidens micrantha ssp. *ctenophylla* is an erect perennial herb, 1.6 to 5-ft. (0.5 to 1.5-m.) tall, and slightly woody at the base. The leaves are simple or occasionally trifoliate, 2.4 to 7.5-in. (6 to 9-cm.) long, with one to nine leaflets that are ovate-lanceolate, 1.4 to 5.3-in. (3.5 to 13.5-cm.) long, 0.2 to 2.2-in. (0.5 to 6-cm.) wide and not ciliate on margins.

Flower heads are small compound cymes, with five to nine rays per head that are 0.3 to 0.6-in. (7 to 16-mm.) long. Rays and corollas are yellow. The achenes are straight, awned, rarely winged, 0.2 to 0.6-in. (5 to 14-mm.) long, and 0.03 to 0.06-in (0.7 to 1.5-mm) wide, and glabrous (Ganders and Nagata 1999, pp. 278-279).

Bidens micrantha spp. ctenophylla (ko`oko`olau) - Kaloko Makai Dryland Forest - Art Whistler, 2006

Bidens micrantha ssp. *ctenophylla* was first described and recognized as a distinct subspecies by Ganders and Nagata (1999, pp. 278-279). It is also recognized as a distinct taxon in Wagner and Herbst (2003), the most recently accepted Hawaiian plant taxonomy.

Listing Status

Bidens micrantha ssp. *ctenophylla* is not currently protected under Hawai`i's endangered species law (HRS, Sect. 195-D) or the Federal Endangered Species Act (16 U. S. C. §1531-1544).

However, they are listed as a "Candidate Species". Candidate Species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. *Bidens micrantha* ssp. *Ctenophylla* were listed as a "Candidate Species" on February 28, 1996

Based on the USFWS evaluation of habitat degradation and loss due to urban development, fire, and competition with nonnative plants, the USFWS has concluded that there is sufficient information to develop a proposed listing rule for this species.

Historic Distribution

Historically, *Bidens micrantha* ssp. *ctenophylla* is known only from the North Kona district on the island of Hawai`i (HBMP 2008).

Current Distribution

There are four wild populations totaling fewer than 60-individuals on State, private, and federal lands (Kaloko-Honokōhau National Historic Park). There are four populations of artificially propagated, out-planted plants, totaling approximately 70 to 80-individuals. Of these, 40-are on Federal lands at Kaloko-Honokōhau National Historic Park, 20 to 30-are on private lands, and 10-are on State lands (five at Pu`u Anahulu and five in the Kohala Mountains). This subspecies is found on the dry leeward slopes of Hualālai volcano on the island of Hawai`i (HBMP 2008).

One wild population at Pu`u Wa`awa`a Wildlife Sanctuary, consisting of five individuals, is protected in an exclosure (M. Donoho, pers. comm. 2007; K. Kawakami, pers. comm. 2007). Out-planted populations are protected by fenced exclosures on State lands at Pu`u Anahulu (five out-planted), and in the Kohala Mountains (five out-planted) (M. Donoho, pers. comm. 2007; K. Kawakami, pers. comm. 2007); on private land at Ka`ūpūlehu (20 to 30-plants) (J. Wagner, pers. comm. 2007); and on Federal land at Kaloko-Honokōhau National Park (approximately 40-plants) (R. Boston, pers. comm. 2007).

All of these populations have ongoing management efforts to reduce fountain grass (M. Donoho, pers. comm. 2007; K. Kawakami pers. comm. 2007; J. Wagner pers. comm. 2007; R. Boston, pers. comm. 2007). The remaining natural populations of this species, numbering fewer than 60-individuals on private and State lands are not currently protected or managed and are subject to development (M. Bruegmann, pers. comm. 2007).

Habitat

Bidens micrantha ssp. *ctenophylla* is found scattered on slopes, ridges, and cliffs in open mixed shrubland to dry *Metrosideros* (`ōhi`a) forest at elevations ranging from 600 to 2,080-ft. (183 to 634-m.). Typical habitat substrate is relatively recently deposited a`ā lava.

Commonly associated native species are: *Psydrax odorata* (alahe`e), *Myoporum sandwicense* (naio), *Reynoldsia sandwicensis* (`ohe), and *Sophora chrysophylla* (māmane) (Ganders and Nagata 1999, pp. 278-279; Hawai`i Biodiversity and Mapping Program (HBMP) 2008).

Threats

Fire is a major threat to *Bidens micrantha* ssp. *ctenophylla* and is exacerbated by the presence of several introduced plant species such as *Pennisetum setaceum* (fountain grass) and *Leucaena leucocephala* (koa haole) (HBMP 2008).

Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity, or from occasional lightning strikes, they are not adapted to recurring fire regimes and do not quickly recover following a fire. Alien plants are often better adapted to fire than native plant species, and some fire-adapted grasses such as fountain grass have become widespread on the west side of the island of Hawai`i, where *B. micrantha* ssp. *ctenophylla* occurs (D'Antonio and Vitousek 1992, pp. 64-65, 70-74; Friefelder *et al.* 1998, pp. 286-287).

Native shrubland and dry forest can thus be converted to land dominated by alien grasses. The presence of such species in Hawaiian ecosystems greatly increases the intensity, extent, and frequency of fire, especially during the dryer months or periods of drought. Fire can destroy dormant seeds as well as plants, even in steep or inaccessible areas. Fires may result from natural causes, or they may be accidentally or intentionally started by humans (Cuddihy and Stone 1990, pp. 29-31; D'Antonio and Vitousek 1992, pp. 70-74; Friefelder *et al.* 1998, pp. 286-287).

In addition to fire, *Bidens micrantha* ssp. *ctenophylla* is threatened by alien plant species that degrade and destroy habitat and outcompete native plants (HBMP 2008). The nonnative plants that are reported to be the greatest threats to *Bidens micrantha* ssp. *ctenophylla* in the Kaloko Honokōhau and Kealakehe population areas are: *Schinus terebinthifolius* (Christmas berry), *Pennisetum setaceum*, and *Leucaena leucocephala* (HBMP 2008).

The population at Ka`ūpūlehu is additionally threatened by *Grevillea robusta* (silk oak) (L. Perry, DOFAW, pers. comm. 2006). Over two million *Grevillea robusta* trees were planted in Hawai`i between 1919 and 1959 in an effort to reduce erosion and to provide timber (Wagner *et al.* 1999, p. 1,086). The leaves produce an allelopathic substance that inhibits the establishment of all species, including it (Smith 1985, p. 191).

Leucaena leucocephala is a naturalized shrub native to the Neo-tropics and cultivated for various purposes. It sometimes forms the dominant element of the vegetation in low elevation, dry, disturbed areas. *Leucaena leucocephala* is an aggressive competitor that can fix nitrogen (Geesink *et al.* 1999, pp. 679-680).

Pennisetum setaceum, a grass native to northern Africa, was introduced to many areas as an ornamental, and is now naturalized in Hawai`i. This grass is a serious pest in dry areas. It is an aggressive colonizer, and out-competes most native species. *Pennisetum setaceum* is also fire-adapted, and burns swiftly and hot, causing extensive damage to the surrounding habitat (O'Connor 1999, p. 1,581).

Schinus terebinthifolius, a shrub native to Brazil, was introduced to Hawai`i in 1911 and is now naturalized in mesic areas (Wagner *et al.* 1999, p. 198). It forms dense thickets and grows even on steep

slopes, and the red berries are attractive to birds (Smith 1989, p. 63). Seedlings grow very slowly and can survive in dense shade, exhibiting vigorous growth if the canopy is cleared (growing at rates of 1 to 2-in. (.03 to .05-m.) per year) (Brazilian Pepper Task Force 1997), leading to the creation of open habitat, and further influencing and increasing its rate of spread.

Environmental Baseline (Status of the Species in the Project Area)
Approximately 375-*Bidens micrantha* ssp. *ctenophylla* were found by the USFWS within the dryland forest preserve during their surveys in March and May 2010. In March and May 2010 they found approximately 40-*Bidens micrantha* ssp. *ctenophylla* outside of the dryland forest preserve boundary, north of Hina Lani.

The *Bidens micrantha* ssp. *ctenophylla* that were found outside of the dryland forest preserve are across Hina Lani Street and are dispersed near the border of the dryland forest preserve. This area is within the T-3 Sub-Urban transect zone (as called for in the Kona Community Development Plan and Village Design Guidelines) of the project layout. The T-3 Sub-Urban transect zone will consist of low density residential uses.

Conservation Needs in the Action Area
Approximately 40-*Bidens micrantha* ssp. *ctenophylla* are found outside of the Kaloko Makai dryland forest preserve, on land that will be developed as part of the Kaloko Makai development. All of the *Bidens micrantha* ssp. *ctenophylla* on the Kaloko Makai property outside of the Kaloko Makai dryland forest preserve will be removed.

The *Bidens micrantha* ssp. *ctenophylla* within the Kaloko Makai dryland forest preserve will remain in place.

Using contractors to implement these actions, FHWA will plant sufficient *Bidens micrantha* ssp. *ctenophylla* individuals so that 40-individuals survive in the preserve and broadcast seed of *Bidens micrantha* ssp. *ctenophylla* at the planting sites in the preserve.

For the first three years, FHWA will control weeds within a 15-ft. (5-m.) buffer around existing and planted *Bidens micrantha* ssp. *ctenophylla* within the Kaloko Makai dryland forest preserve.

2.5 Cumulative Effects

Cumulative effects include the impacts of future state, local, or private actions that are reasonably certain to occur in the action area considered in this HCP. Much of the property surrounding the Kaloko Makai dryland forest preserve is privately owned by Kaloko Makai. However, portions of the dryland forest preserve border properties owned by 327 Kona LLC and Lanihau Properties. Development at either of these sites could affect plant species within the Kaloko Makai dryland forest preserve.

3.0 MITIGATION

3.1 Kaloko Dryland Forest

3.1.1 History of Hawaiian Dryland Forests

Although not as well known as the rainforests, Hawaiian lowland dry forests are a biologically diverse and interesting ecosystem found from sea level to perhaps 2,500-ft. in elevation. For native Hawaiians, these forests were a source of food, fiber, medicine and materials and were important locations for rituals.

They are a unique and cherished resource that still support many of Hawai`i's endangered plant species, but which have been damaged by land clearing, wildfires, grazing, and the spread of alien species. Writing in 1913, Joseph Rock remarked that despite some degradation, dryland forests contained the greatest diversity of trees of any Hawaiian forests.

By the 1990s, Mueller-Dombois and Fosberg (1998) could find only four relatively intact remnants of Hawaiian dryland forest in the entire island chain, one at Ka`ūpūlehu on the Big Island, and one each on Maui, Lāna`i and O`ahu. Even these were highly degraded due to grazing, alien plants and fire.

In reality, Hawaiian dry forests have not been "pristine" for the last 1,000-years, and there is little knowledge of their primeval makeup or appearance. The Hawaiian people have lived and farmed in Kona for over 1,200-years. Between 1100 and 1650 AD the population grew rapidly, and with it, intensive agriculture. The Kona Field System stretched from Kealakekua to Kailua, from the coast to about 2,000-ft. elevation. Archaeological remains indicate that dryland agriculture was successful at these elevations wherever there was 50-in. or more average annual rainfall.

Hawaiians living in North Kona presumably gathered resources from the nearby dryland forest. Throughout Hawai`i, trees were used for house timber, implements of all kinds and firewood for cooking. The dryland forest was undoubtedly altered by the harvest of useful trees and other plant products. Furthermore, the slopes may have been burned from time to time to favor the spread and growth of pili grass (*Heteropogon contortus*), useful for thatching. These fires would have eliminated certain plant species and favored others.

After Western contact in 1778, introduced plant and animal species gradually but dramatically changed the dryland forest. Through the nineteenth and most of the twentieth century, domestic and feral cattle, goats and other ungulates grazed and browsed the Kona dryland forest.

Many writers noted severe degradation of the vegetation. Native plant species that could not tolerate this animal pressure were replaced by more tolerant introduced species, including fountain grass (*Pennisetum setaceum*), which competes for water and nutrients and tolerates and indeed spreads fire, to which native woody plants are not well adapted.

3.1.2 Ecological Dynamics of Dryland Forests

Several ecological concepts require review in order to properly frame the management and restoration efforts within the Kaloko Makai Dryland Forest: ecological succession in Hawaiian dryland forests, episodic reproduction and anthropogenic disruptive factors.

Ecological Succession

Ecological succession means the development of the ecosystem over time on a piece of raw land. In general, succession starts with small, slow-growing plants that begin to build the soil and increase the moisture and nutrients on the site. These are displaced by larger plants that continue the process, and are in turn replaced by still larger, long-lived plants.

Succession in environments with adequate rainfall usually leads to a forest of relatively large trees that is more or less stable over the long term. In Hawaiian dryland forests, succession proceeds in a different way. All Hawaiian lands began as volcanic surfaces.

Seedlings of `ōhi`a (*Metrosideros polymorpha*) are usually the first plants visible on young lava flows. These trees begin growth in lava cracks and other protected sites that can hold moisture and soil particles. The `ōhi`a drops leaves and contributes to soil development and produces some shade that moderates the heat, light and dryness of the open lava flows. In the dry Hawaiian environments, these pioneering `ōhi`a form an open forest with other native shrubs and trees that get established as the soil and moisture conditions improve. Eventually, the `ōhi`a forest is replaced by dryland forests and shrublands.

Typically, each species of plant has a certain place in succession, perhaps as an early pioneer, or in middle or late succession. In North Kona, `ōhi`a can be seen on lava flows 1,500 to 3,000-years old, but not on older flows. The flows of the project area are between 3,000 and 5,000-years old, explaining why `ōhi`a is not found here. These older flows may have originally been dominated by lama (*Diospyros sandwicensis*) or `a`ali`i (*Dodonaea viscosa*) and may have contained a diversity of other native plants. The endangered trees of the area, uhiuhi, hala pepe (*Pleomele hawaiiensis*), and `alea (*Nothocestrum breviflorum*), are plants of middle and late succession, not pioneers.

Episodic Reproduction

Episodic reproduction caused by fluctuations in rainfall significantly influences the dryland forest. Mean annual rainfall between 20 to 50-in. per year (DLNR 1986), coupled with warm temperatures year-round produce "xeric" conditions, in which water is the predominant factor that determines which species can be successful.

Observations in the dryland forest have shown that many germinated seedlings do not survive long. Although modern problems such as predation by ungulates, insects or rodents take their toll, slow growth and low vigor due to lack of water is the over-riding problem. Native dryland forest species reproduced "episodically," meaning only during the occasional periods of higher than average rainfall. More than one consecutive wet year may be necessary for successful establishment of many native tree seedlings and decades of dry years may intervene between these favorable episodes. Given this episodic pattern of reproduction, dryland forests would be expected to have many "uneven" aspects of structure and function.

Anthropogenic (Human-Induced) Disruption

Anthropogenic (human-induced) disruption, especially by ungulates, fountain grass, and fire, are problems dryland forests did not have during their original development as a community type. The major result of these disruptions is that the native dryland forest contains almost entirely old individual trees and very few young saplings or seedlings. Many of the old trees have already died, and many that remain are decadent or senescent. As they die one-by-one, their species are being lost from the Hawaiian landscape, and in some cases survive only in managed plantings.

Ungulates destroy seedlings and young trees. This alone can eliminate native species. Grasses are more tolerant of grazing and can increase their cover as the native species recede. Fountain grass has been particularly successful in Kona. It has the ability to become established on previously barren lava flows and to survive extremely dry conditions.

Fountain grass efficiently absorbs water and produces large quantities of grass when it rains. This grass may shade the seedlings of native plants, reducing their growth rate, and then under dry conditions, the fountain grass carries fire through the habitat. The grass is fire-adapted, meaning it readily grows back after fire, while most native tree seedlings are killed by grass fires and even adult native trees are poorly to moderately tolerant of fire.

Research and observations have shown that ungulates, fountain grass and fire have combined to almost entirely halt regeneration of the Hawaiian dryland forests throughout the archipelago. It appears that only substantial and successful efforts to reduce these human-caused disruptions can restore this ecosystem.

3.1.3 Threats to Dryland Forests

The dryland forest habitat of the plants included in this HCP have undergone extreme alteration because of past and present land management practices, including deliberate alien animal and plant introductions; agricultural, commercial, and urban development and recreational use. Natural disturbances such as volcanic activity also destroy habitat and can have a significant effect on small populations of plants. Competition with alien plants as well as destruction of plants and modification of habitat by introduced animals are the primary threats facing all five of the species.

Beginning with Captain James Cook in 1792, early European explorers introduced livestock, which became feral, increased in number and range, and caused significant changes to the natural environment of Hawai`i. The 1848 provision for land sales to individuals allowed large-scale agricultural and ranching ventures to begin. So much land was cleared for these enterprises that climatic conditions began to change, and the amount and distribution of rainfall were altered. Plantation owners supported reforestation programs which resulted in many alien trees being introduced in the hope that watersheds could be conserved.

Past and present activities of introduced alien mammals are the primary factors in altering and degrading vegetation and habitats on the island of Hawai`i where populations of the five species occur. Feral ungulates trample and eat native vegetation and disturb and open areas. This causes erosion and allows the entry of alien plants.

Cattle (*Bos taurus*), the wild progenitor of which was native to Europe, northern Africa, and southwestern Asia, were introduced to the Hawaiian Islands in 1793. Large feral herds developed as a result of restrictions on killing cattle decreed by King Kamehameha I. While small cattle ranches were developed on Kaua`i, O`ahu, and West Maui, very large ranches of tens of thousands of acres were created on East Maui and Hawai`i. Much of the land used in these private enterprises was leased from the State or was privately owned and considered Forest Reserve and/or Conservation District land.

Feral cattle can presently be found on the island of Hawai`i, and ranching is still a major commercial activity there. Hunting of feral cattle is no longer allowed in Hawai`i. Cattle eat native vegetation, trample roots and seedlings, cause erosion, create disturbed areas into which alien plants invade and

spread seeds of alien plants in their feces and on their bodies. The forest in areas grazed by cattle becomes degraded to grassland pasture, and plant cover is reduced for many years following removal of cattle from an area. Several alien grasses and legumes purposely introduced for cattle forage have become noxious weeds.

The dryland forests on the island of Hawai'i were degraded in the past by feral cattle, and this has had effects which still persist. While the Kaloko `a`ā flow shows no evidence of cattle grazing, the surrounding pāhoehoe flow does show such evidence, and populations of *Pleomele hawaiiensis* and *Bidens micrantha ssp. ctenophylla* in other locations on the island of Hawai'i are threatened by cattle.

Goats (*Capra hircus*), originally native to the Middle East and India, were successfully introduced to the Hawaiian Islands in 1792, and currently there are populations on Kaua`i, O`ahu, Molokai, Maui, and Hawai`i. On Hawai`i, goats damage low-elevation dryland forest, montane parkland, subalpine woodlands, and alpine grasslands. Goats are managed in Hawai`i as a game animal, but many herds populate inaccessible areas where hunting has little effect on their numbers. Goat hunting is allowed year-round or during certain months, depending on the area.

Goats browse on introduced grasses and native plants, especially in drier and more open ecosystems. They also trample roots and seedlings, cause erosion and promote the invasion of alien plants. They are able to forage in extremely rugged terrain and have a high reproductive capacity. Goat damage within the Kaloko `a`ā flow is minimal, although goat droppings are found on the pāhoehoe flow surrounding it, and *Pleomele hawaiiensis* is currently threatened by goats at other locations.

Overutilization for commercial, recreational, scientific or educational purposes. Overutilization is not known to be a factor, but unrestricted collecting for scientific purposes or excessive visits by individuals interested in cultivating native plants could result from increased publicity and would seriously impact all species, but especially those species with fewer than 100-individuals. Increased human visitation could also promote greater invasion by alien pest plant and insect species.

Disease and predation. Cattle, goats or sheep have been reported browsing on native dryland forest plant species. Since the five plants in this HCP are not known to be unpalatable to these ungulates, predation is a probable threat, potentially affecting all five of the species. Goats are the most likely species to threaten the five plants, since they are the only one of the three ungulate species in the area at present.

Of the four species of rodents which have been introduced to the Hawaiian Islands, the species with the greatest impact on the native flora and fauna is probably *Rattus rattus* (roof or black rat), which now occurs on all the main Hawaiian Islands around human habitations, in cultivated fields, and in dry to wet forests. Roof rats, and to a lesser extent *Mus musculus* (house mouse), *Rattus exulans* (Polynesian rat), and *Rattus norvegicus* (Norway rat), eat the fruits of some native plants, especially those with large, fleshy fruits.

Many native Hawaiian plants produce their fruit over an extended period of time, and this produces a prolonged food supply which supports rodent populations. While no rat damage has been observed on the five plant species in this HCP, extensive rat damage to native plants has been reported in dryland forest patches in surrounding areas.

Other natural or manmade factors affecting its continued existence. The small numbers of populations and individuals of several of these taxa increase the potential for extinction from naturally occurring events. The limited gene pool may depress reproductive vigor, or a single human-caused or natural environmental disturbance could destroy a significant percentage of the individuals or the only known extant population. This constitutes a major threat to *Neraudia ovata* and *Nothocestrum breviflorum*.

The original native flora of Hawai`i consisted of about 1,000-species, 89% of which were endemic. Of the total native and naturalized Hawaiian flora of 1,817-species, 47% were introduced from other parts of the world and nearly 100-species have become pests. Naturalized, introduced plants compete with native plants for space, light, water, and nutrients. Some of these plants were brought to Hawai`i by various groups of people, including the Polynesian immigrants, for food or cultural reasons.

Plantation owners, alarmed at the reduction of water resources for their crops caused by the destruction of native forest cover by grazing feral animals, supported the introduction of alien tree species for reforestation. Ranchers intentionally introduced pasture grasses and other species for agriculture, and sometimes they inadvertently introduced weed seeds as well. Other plants were brought to Hawai`i for their potential horticultural value.

Pennisetum setaceum (fountain grass) is a fire-adapted bunch grass that has spread rapidly over bare lava flows and open areas on the island of Hawai`i since its introduction in the early 1900s. Fountain grass is particularly detrimental to Hawai`i's dryland forests because it is able to invade areas once dominated by native plants, where it interferes with plant regeneration, carries fires into areas not usually prone to fires and increases the likelihood of fires. While fountain grass has not established extensively in the Kaloko `a`ā flow, it is a serious threat and can spread rapidly. Small patches have already become established and the surrounding area is a constant source of new seeds.

After escaping from cultivation, *Schinus terebinthifolius* (Christmas berry) became naturalized on most of the main Hawaiian Islands. Christmas berry is sparsely scattered through the lower reaches of the Kaloko `a`ā flow, becoming more densely distributed with increasing elevation and the accompanying increase in rain fall.

Lantana camara (lantana), brought to Hawai`i as an ornamental plant, is an aggressive, thicket-forming shrub which can now be found on all of the main islands in dry and mesic forests, dry shrub-lands, and other dry, disturbed habitats. Lantana is sparsely scattered through the Kaloko area.

Leucaena leucocephala (koa haole) is a naturalized shrub which is sometimes the dominant species in low elevation, dry, disturbed areas on all of the main Hawaiian Islands. Koa haole is scattered through the lower elevations of the Kaloko `a`ā flow, becoming more densely distributed with increasing elevation and the accompanying increase in rain fall. It also grows in extremely thick stands on the surrounding pāhoehoe flows, where more soil is available.

Natural changes to habitat and substrate can result in the death of individual plants as well as the destruction of their habitat. This especially affects the continued existence of species or populations with limited numbers and/or narrow ranges and is often exacerbated by human disturbance and land use practices. Kaloko is on the flanks of Hualālai, which has been dormant since 1801, but has had occasional earthquakes, which indicate that its core is still active. Volcanic activity could result in the destruction of the populations of all five plant species in this HCP.

Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity and from occasional lightning strikes, they are not adapted to recurring fire regimes and are unable to recover well following a fire.

Alien plants are often better adapted to fire than native plant species and some fire-adapted grasses have become widespread in Hawai`i. Native shrubland and dryland forest can thus be converted to land dominated by alien grasses.

The presence of such species in Hawaiian ecosystems greatly increases the intensity, extent, and frequency of fire, especially during drier months or drought. Fire-adapted alien plants can reestablish in a burned area, resulting in a reduction in the amount of native vegetation after each fire. Fire can destroy dormant seeds as well as plants, even in steep or inaccessible areas.

Fires may result from natural causes or they may be accidentally or purposely set by humans. Three fires have occurred in the nearby Pu`u Wa`awa`a/Ka`ūpūlehu dryland forests over the last ten years, and have destroyed habitat as well as individuals of many endangered and proposed endangered species, including *Pleomele hawaiiensis*.

3.1.4 Kaloko Makai Dryland Forest Preserve - Preservation of 150-acres

The Kaloko dryland forest is approximately 265-acres spanning three property owners with a majority of the dryland forest occurring on Kaloko Makai property. Although the Kaloko dryland forest is small in size and at very low elevation and rainfall, the Kaloko dryland forest represents some of the best remaining dryland forest outside of Pōhakuloa Training Area.

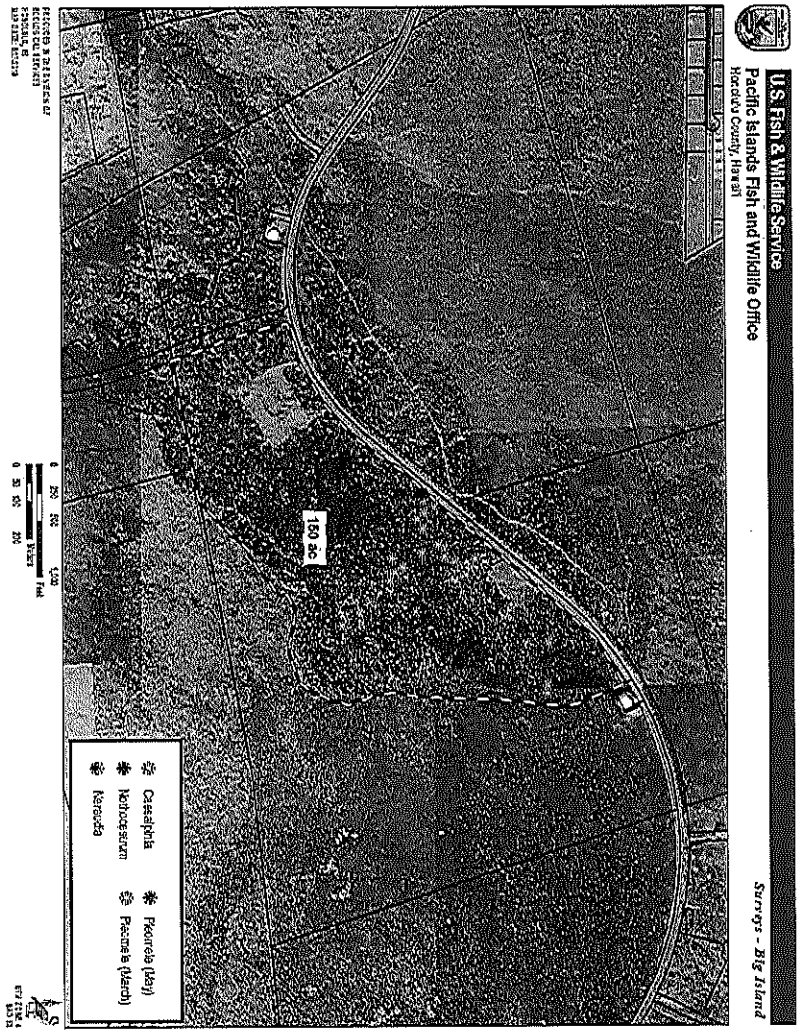
The dryland forest is one of the few remaining parcels of dryland forest that has not been overrun by fountain grass and it appears to have escaped from any ungulate pressures, due to the rough nature of the substrate.

Knowing the importance of this dryland forest, Kaloko Makai incorporated a large portion (150-acres) of the dryland forest into their preliminary design as the Kaloko Makai Dryland Forest Preserve. Kaloko Makai representatives approached the USFWS regarding the dryland forest and its protection. The USFWS surveyed the dryland forest area in March and May of 2010 and determined that of the 265-acres, 150-acres of the dryland forest should be protected and incorporated into a dryland forest management area, free from development.

These 150-acres contain the most species and best habitat for reproduction of native species and the dryland forest ecosystem. Kaloko Makai agreed to the preservation of the 150-acres into the Kaloko Makai Dryland Forest Preserve.

These 150-acres will be set aside and preserved as a dryland forest preserve in perpetuity, thus ensuring the continuation of this dryland forest ecosystem. The preservation of these 150-acres is the single most important step in preserving the dryland forest ecosystem at Kaloko Makai. By preserving these 150-acres, Kaloko Makai is ensuring that the Kaloko dryland forest is preserved for generations to come.

The County of Hawai`i and FHWA have committed to separate specific management actions through informal Section 7 Consultation with USFWS; these actions and associated funding are not part of the Kaloko Makai project, but are included in this HCP by reference. FHWA is not funding the Kaloko Makai actions and its involvement in the dryland forest is associated with the Ane Keohokālole Highway, not the Kaloko Makai project.



3.2 Development and Management of the Kaloko Makai Dryland Forest Preserve

Kaloko Makai (in cooperation and coordination with the County of Hawai'i and FHWA) will manage the Kaloko Makai Dryland Forest Preserve as a 150-acre preserve (portions of TMK (3) 7-4-021:005). Management will be contracted to an entity with experience in dryland forest restoration and conservation.

The dryland forest preserve will be subdivided into a separate parcel. Kaloko Makai will prepare a subdivision map and will then conduct the final boundary staking, mapping and recordation necessary to accomplish the subdivision.

The dryland forest preserve, shall be protected from major physical disturbance (i.e. construction, clearing, grading, digging or filling). The area to be protected will be clearly delineated and signs will be posted so that the restrictions on disturbance are clearly visible.

A previously graded portion of land within the preserve will be used as a staging and propagation area for management actions within the Kaloko Makai dryland forest preserve. The staging area will serve as a central site for a variety of activities including parking, plant propagation, plant nursery, laboratories, dip tank etc. These facilities will enable management to fulfill the obligations of the HCP.

FHWA is using the Kaloko Makai Dryland Forest Preserve as an out-planting area for their management actions, as described in this HCP. Additionally, Kaloko Makai will similarly work with others to use the Kaloko Makai Dryland Forest Preserve as an out-planting area.

The major threats to the dryland forest preserve are fire and invasive species, thus, these issues will be the top priorities in the management of the Kaloko Makai dryland forest preserve.

3.2.1 Fencing

As recommended by the USFWS, FHWA will utilize contractors to install a 4-ft. (1.2-m) woven mesh fence along the east side of the Ane Keohokālole Highway. During construction, FHWA will also establish an Area-of-Potential-Effect (APE) fence that follows the roadway corridor's limits of grading prior to roadway grading. Additionally, during construction, FHWA will establish a protective buffer around the existing `aiea tree with orange construction fencing.

3.2.2 Fire Control

Of concern to the DLNR-DOFAW is the increase in fire danger from an increase in activity around the dryland forest preserve. With backyards fronting the preserve, use of fire pits, barbeques and other sources of fire increase the chance that fire may affect the dryland forest preserve.

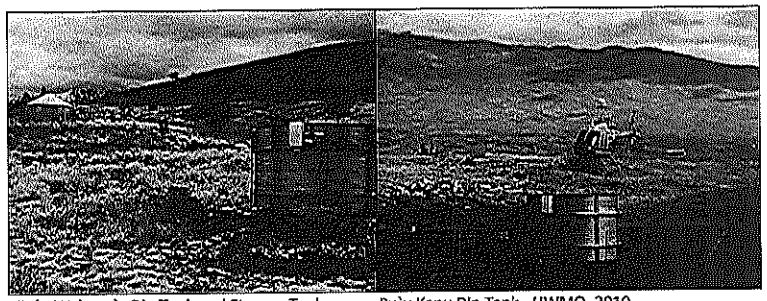
Kaloko Makai has planned single-family uses adjoining the dryland forest preserve. It is believed that this use has less risk compared to multi-family or commercial uses. Since the dryland forest preserve will border housing developments, building setbacks will be developed to keep housing an appropriate distance from the dryland forest preserve. Appropriate landscaping will also be employed within the housing developments that can act as barriers if fire was to occur.

The Kaloko Makai Dryland Forest Preserve Fire Management Plan is included as Appendix A. Appropriate signage will be developed to encourage public cooperation and discourage trespassing, vandalism or arson.

Fire fighting resources available near the Kaloko Makai dryland forest preserve will be identified and information will be provided to fire stations to assist them in protecting the dryland forest preserve from fire. Kaloko Makai will also investigate water sources, which may be used to suppress fires if they were to occur within the dryland forest preserve.

Kaloko Makai will install a helicopter dip tank within the Kaloko Makai dryland forest preserve. It will be placed in the previously graded portion of land within the preserve where the staging and propagation area for management actions will be within the dryland forest preserve.

Dip tanks decrease the travel time required between bucket drops of water during a fire, and, most importantly, can allow first responders to more quickly respond to a fire in the first hour, which can be the difference between a 100-acre or several thousand acre fire. Below are photos of tanks that have been installed at Pu`u Kapu near Waimea and at Pu`u Wa`awa`a, which helps to protect endangered dryland forests.



Pu`u Wa`awa`a Dip Tank and Storage Tank  Pu`u Kapu Dip Tank - HWMO, 2010

3.2.3 Invasive Species Control

Due to the surrounding urban development, there are no known feral ungulates within this region of Kona. If, however, ungulates are found within the Kaloko Makai dryland forest preserve, they will be removed.

Invasive species removal will be one of the top priorities within the dryland forest preserve. After informal consultation with USFWS, FHWA has agreed to control weeds in a 15-foot (5-meter) buffer around existing and/or planted *Nothocestrum breviflorum, Caesalpinia kavaiensis, Neraudia ovata, Pleomele hawaiiensis* and *Bidens micrantha spp. ctenophylla* within the Kaloko Makai dryland forest preserve.

Likewise, FHWA will control weeds in a 15-foot (5-meter) buffer around the existing *Nothocestrum breviflorum* outside of the Kaloko Makai dryland forest preserve.

FHWA has also agreed to controlled weeds in the abandoned construction staging area for Hina Lani Street and along a 15-foot (5-meter) buffer of the Ane Keohokālole Highway. FHWA management measures will run for three years.

Kaloko Makai will continue management protocols initiated by FHWA for the *Nothocestrum breviflorum, Caesalpinia kavaiensis, Neraudia ovata* and *Pleomele hawaiiensis*, after the three-year FHWA management actions has expired and after land use entitlements are granted for the proposed development. The Kaloko Makai Dryland Forest Preserve Weed Management Plan is included as Appendix B, and further outlines weed management and control efforts within the preserve.

A protocol will be developed to avoid introduction of invasive plant species by imported nursery stock, worker shoes, clothing, tools and other sources.

Management will contact DLNR-DOFAW and USFWS 30 days prior to controlling weeds around existing endangered plants, so that DLNR-DOFAW and USFWS can train workers who will be controlling weeds in the preserve (1) how to identify rare/endangered plants and (2) proper techniques for working in close proximity to these plants.

DLNR-DOFAW and USFWS may survey the Kaloko Makai dryland forest preserve for additional rare and listed species and mark or flag those individuals.

3.3 Construction Activities

Approximately 40-*Bidens micrantha* ssp. *ctenophylla* and 2-*Pleomele hawaiiensis* are found outside of the Kaloko Makai dryland forest preserve, on land that will be developed as part of the Kaloko Makai development.

The approximately 40-*Bidens micrantha* ssp. *Ctenophylla*, will be destroyed by construction activities.

The two *Pleomele hawaiiensis* found outside of the Kaloko Makai dryland forest preserve will be removed and transplanted (if feasible) to the Kaloko Makai dryland forest preserve before construction (grubbing/grading) activities begin. This process is described in more detail in section 3.4 - Transplanting of *Pleomele hawaiiensis* (hala pepe.)

The destruction of the 40-*Bidens micrantha* ssp. *Ctenophylla* and transplanting (where feasible) of the two *Pleomele hawaiiensis* found outside of the Kaloko Makai dryland forest preserve are the only activities which are believed to directly impact listed and candidate species (candidate species receive no statutory protection under the Endangered Species Act,) on the property.

However, construction activity may indirectly affect listed species within the Kaloko Makai dryland forest preserve. Thus, a number of measures will be employed during construction to minimize potential impacts to endangered plants within the Kaloko Makai dryland forest preserve and the individual *Nothocestrum breviflorum*, outside of the Kaloko Makai dryland forest preserve.

3.3.1 Best Management Practices

Best Management Practices (BMPs) will be employed by Kaloko Makai contractors during construction activities. BMPs are mitigation measures applied to construction activities to help ensure that development is conducted in an environmentally responsible manner.

3.3.2 Construction Contract Conditions

Kaloko Makai will develop a set of special construction contract conditions to be included in construction contracts that clearly outline environmental constraints. These contract conditions are intended to minimize impacts by ensuring that construction personnel do not enter the dryland forest preserve and that they are aware of the threats that fire, invasive species/alien plants and physical disturbance pose to the Kaloko Makai dryland forest preserve and the plants contained within.

Conditions will be included as contractual requirements for the mass-grading around the Kaloko Makai dryland forest preserve and will be included in all future Kaloko Makai contracts for projects where work adjacent to the dryland forest preserve is being proposed.

Contract conditions will include severe contractual penalties for any encroachments into the dryland forest preserve. They will also require that no heavy equipment (i.e., bulldozers) shall be used in any of the undisturbed portions of the dry forest preserve. Bulldozing will diminish the ecological integrity of this relatively pristine area because these areas are more susceptible to weed invasion and the soils and hydrology will be altered. Final contract conditions will be provided to DLNR-DOFAW and the USFWS for their review.

3.4 Transplanting of *Pleomele hawaiiensis* (hala pepe)

Two *Pleomele hawaiiensis* are found outside of the Kaloko Makai dryland forest preserve, on land that will be developed as part of the Kaloko Makai development. The two plants outside of the dryland forest preserve will be removed and transplanted (where feasible) by Kaloko Makai contractors to the Kaloko Makai dryland forest preserve. The USFWS and DLNR-DOFAW will be consulted as to where the transplanting should occur within the Kaloko Makai dryland forest preserve.

3.5 Plantings

Using contactors, to implement these actions, FHWA will use best efforts to collect genetic material, propagate and plant *Nothocestrum breviflorum* (`alea), *Pleomele hawaiiensis* (hala pepe), *Neraudia ovata* (ma`oloa), *Caesalpinia kavaiensis* (uhiuhi) and *Bidens micrantha* ssp. *Ctenophylla* (ko`oko`olau) within the Kaloko Makai dryland forest preserve.

3.5.1 *Nothocestrum breviflorum* (`alea)

Using contactors, FHWA will use best efforts to collect genetic material of *Nothocestrum breviflorum*, propagate and plant so that 30-individuals survive in the Kaloko Makai dryland forest preserve.

3.5.2 *Pleomele hawaiiensis* (hala pepe)

Using contactors, FHWA will use best efforts to collect genetic material, propagate and plant *Pleomele hawaiiensis* so that 40-individuals survive in the Kaloko Makai dryland forest preserve.

Additionally, using contactors, Kaloko Makai will use best efforts to collect genetic material, propagate and plant *Pleomele hawaiiensis* so that 6-individuals survive in the Kaloko Makai dryland forest preserve. The 6-individuals represent a 3-for-1 replacement of the 2-*Pleomele hawaiiensis* outside of the dryland forest preserve which will be disturbed. The USFWS and DLNR-DOFAW will be consulted as to where the plantings should occur within the Kaloko Makai Dryland Forest Preserve.

3.5.3 *Neraudia ovata* (ma`oloa)

Using contactors, FHWA will use best efforts to collect genetic material, propagate and plant *Neraudia ovate* so that 30-individuals survive in the Kaloko Makai dryland forest preserve.

3.5.4 *Caesalpinia kavaiensis* (uhiuhi)

Using contactors, FHWA will use best efforts to collect genetic material, propagate and plant *Caesalpinia kavaiensis* so that 30-individuals survive in the Kaloko Makai dryland forest preserve.

3.5.5 *Bidens micrantha* ssp. *Ctenophylla* (ko`oko`olau)

Using contractors, FHWA will plant sufficient *Bidens micrantha* ssp. *ctenophylla* so that 40-individuals survive in the preserve and broadcast seed of *Bidens micrantha* ssp. *ctenophylla* at the planting sites in the preserve.

3.6 Preservation of *Nothocestrum breviflorum* (`alea)

Using contractors to implement these actions, FWHA will establish a protective buffer around the existing *Nothocestrum breviflorum* with orange construction fencing during construction.

After construction, using contractors, Kaloko Makai will develop a 25-ft. (7.62-m.) buffer between the plant and any structure. The plant will be incorporated into landscaping within the 25-ft. buffer. Appropriate fencing will be incorporated into the landscaping to protect the plant.

3.7 Success Goals

The goal of this HCP is to initiate and sustain a program which would result in a net benefit to the listed species within the Kaloko Makai dryland forest preserve, thus, contributing towards the recovery of the species as required by HRS Chapter 195D-30.

3.7.1 Actions and Measures of Success Criteria for Kaloko Makai HCP

After numerous and extensive surveys focused on identifying endangered species within the Kaloko Makai project, only two listed species (3 individual plants) and one candidate species (40 individual plants) were found outside of the dryland forest preserve. There are numerous endangered species within the dryland forest preserve.

Proposed mitigation measures in the HCP include protection of habitat and management of threats to several endangered species including hala pepe, 'alea, ma'oloa and uhiuhi, as well as the candidate species ko'oko'olau.

1) Number of plants
   a. Propagating and planting three listed plants for every one taken (3-for-1)
   b. Survival of individual plants equates to survival for at least three years, the third year without supplemental water

2) Addressing threats
   a. Establishing dryland forest preserve in perpetuity, thereby protecting the habitat from development
   b. Implementation of a fire plan, including development of water system within neighboring project, installation of a dip tank, setting aside land for County fire station, siting of lower risk land uses adjoining preserve, signage, etc
   c. Weeding protocols, removing invasive species surrounding each endangered plant in the preserve

3) Term – 20 years (Kaloko Makai will continue management protocols initiated by FHWA for the *Nothocestrum breviflorum, Caesalpinia kavaiensis, Neraudia ovata* and *Pleomele hawaiiensis*, after the three-year FHWA management actions has expired and after land use entitlements are granted for the proposed development.)

4) Incidental Take License
   As a result of this HCP and management measures, an Incidental Take License is requested for the take of all endangered species and candidate species that may be situated within the Kaloko Makai development area. Through this HCP applicant is applying for the issuance of an Incidental Take License by DLNR to enable the removal of all *Nothocestrum breviflorum, Pleomele hawaiiensis, Neraudia ovate, Caesalpinia kavaiensis* and *Bidens micrantha* ssp. *Ctenophylla* (if found) outside of the Kaloko Makai Dryland Forest Preserve, within the Kaloko Makai project.

FHWA Success Goals

Species	Success (Survival) Goal* (best efforts to seek to achieve the following**)
Nothocestrum breviflorum (`alea)	30 planted individuals survive in the preserve
Pleomele hawaiiensis (hala pepe)	40 planted individuals survive in the preserve
Neraudia ovata (ma`oloa)	30 planted individuals survive in the preserve
Caesalpinia kavaiensis (uhiuhi)	30 planted individuals survive in the preserve
Bidens micrantha spp. ctenophylla (ko`oko`olau)	40 planted individuals survive in the preserve

Kaloko Makai Success Goals

Species	Success (Survival) Goal* (best efforts to seek to achieve the following**)
Pleomele hawaiiensis (hala pepe)	6 planted individuals survive in the preserve

*Survival of individual plants equates to survival for at least three years, the third year without water. However, because of the harsh and variable conditions at the out-planting sites, USFWS's limited

horticultural knowledge of these endangered and candidate plants and a scarcity of propagation material, an Implementation Team composed of Hawai'i Forestry Industry Association (HFIA) staff, USFWS staff and other botanists and horticulturalists familiar with dry forest restoration techniques, will be established in order to assist HFIA in adaptively managing the implementation of this project.

** These plant species are known to be difficult to propagate and have a long time span to produce seed and progeny. Best efforts will be made to seek to achieve the above.

If the above success goals are not achieved, one or more of the following responses are appropriate:

1. Continue with management program for a longer timeframe,
2. Intensify threat control,
3. Implement species augmentation, or
4. Re-evaluate goals

3.7.2 Management Goals

Based on the mitigation measures and criteria for success found in other Hawaii HCPs, the Kaloko Makai HCP will be considered a success if:

- The number of plants that are propagated, planted and survive in the Preserve exceed the number of plants taken (representing a net gain for the species)
- Management measures make meaningful contributions toward addressing the major threats that habitat of the taken species face (major threats include development, fire, invasive species)

The combination of providing and preserving important habitat for the covered plant species, and addressing major threats to the habitat of listed species, combined with the very low level of anticipated take, means that the collection of mitigation measures described in this HCP will provide a substantial net benefit and gain to the listed plant species.

The overarching goal of on-site habitat management is to ensure that on-the-ground management actions associated with maintaining habitat within the preserve continue to provide habitat for the covered plant species. This will be obtained by:

1. Creating and actively managing the 150-acre Kaloko Makai Dryland Forest Preserve.
2. Through FHWA funding its separate actions, a significant number of management measures will be implemented.
3. Maintaining a stable population of each listed and candidate species within the Preserve.
4. Maintaining an effective population of flowering and seed producing plants (listed and candidate species) over the term of the HCP.
5. Monitoring the listed and candidate species within the preserve to determine progress toward attaining population stability.
6. Controlling threats from fire, ungulates and invasive species.

Successful Preserve Management

Management success will be measured by the following:

- Establishment and survival of "taken" listed species, *Pleomele hawaiiensis* (hala pepe.) (Survival of individual plants equates to survival for at least three years, the third year without water.)
- Reduction of introduced plants and development of cost effective methods to control introduced/invasive species. (The number of introduced/invasive species in the Preserve are less every year and weed management measures make meaningful contributions toward addressing the threat that weeds have on the dryland forest habitat.)
- Natural reproduction of listed and candidate species, as well as other native plants in the preserve. (The number of plants that are propagated, planted and survive in the Preserve exceed the number of plants taken (representing a net gain for the species.)
- No wildfires in preserve. (Fire management measures make meaningful contributions toward addressing the fire threat to habitat.)

3.8 Ane Keohokālole Highway Construction

As a separate, unrelated project, the Federal Highways Administration (FHWA) and the County of Hawai'i are constructing the Ane Keohokālole Highway between Kealakehe Parkway and Hina Lani Street. A portion of the highway cuts through the Kaloko Makai property, adjoining one side of the Kaloko Makai Dryland Forest Preserve. This highway project is separate from the Kaloko Makai project.

The U.S. Fish and Wildlife Service (USFWS) has begun an informal Section 7 consultation for the Ane Keohokālole Highway project with the FHWA and the County of Hawai'i. The proposed Ane Keohokālole Highway may affect the following endangered plants in the vicinity of Kaloko Makai: (1) `alea *(Nothocestrum breviflorum)*; (2) uhiuhi *(Caesalpinia kavaiensis)*; (3) ma`oloa *(Neraudia ovata)*; and (4) hala pepe *(Pleomele hawaiiensis)*. Additionally the project may have potential impacts on the candidate taxon for listing, ko`oko`olau *(Bidens micrantha* ssp. *ctenophylla)*.

Part of the informal Section 7 consultation process has been the drafting of conservation measures which the FHWA and the County of Hawai'i have agreed to implement. These conservation measures and associated funding are part of the management actions of this HCP and are listed below:

1. Work with adjacent landowners to preserve a total of 150 ac.;

2. Collect genetic material, propagate and outplant uhiuhi and ma`oloa so that 30 individuals of each survive in the preserve;

3. Collect genetic material, propagate and outplant hala pepe so that 40 individuals survive in the preserve;

4. Collect genetic material and propagate `alea, uhiuhi, ma`oloa, and hala pepe so that 30 individuals, in each of two locations to be determined in coordination the USFWS, survive out-planting;

5. Collect genetic material of `alea from three locations, propagate and outplant so that 30 individuals survive in the preserve and two populations of 30 survive at locations to be determined in coordination with the USFWS;

6. Outplant sufficient ko`oko`olau individuals so that 40 individuals survive in the preserve and broadcast seed of ko`oko`olau at the out-planting sites at the preserve;

7. Outplant enough individuals of ko`oko`olau so that two populations of 90 survive, at locations to be determined in coordination with the USFWS;

8. Control weeds in a 15-foot (ft) (5-meter (m)) buffer around existing endangered plants (`aiea, uhiuhi, ma`oloa, hala pepe and ko`oko`olau) in the preserve;

9. Control weeds in the abandoned construction staging area for Hina Lani Street;

10. Install a 4-ft (1.2-m) woven mesh fence along the east side of the Ane Keohokālole Highway;

11. Control weeds along a 15-ft (5-m) buffer of the Ane Keohokālole Highway;

12. Establish a protective buffer during construction around the existing `aiea tree with orange construction fencing; (completed)

13. Establish an Area-of-Potential-Effect (APE) fence that follows the roadway corridor's limits of grading prior to roadway grading; (completed)

14. Before that APE fence line is grubbed in the dry land forest area, the contractor will first walk the boundaries and flag any ko`oko`olau plants that may be on, or just inside, the grading corridor. These ko`oko`olau plants will be purposely avoided as the contractor puts in the APE fencing, even if it means having to adjust the site grading to do so; (completed)

15. The FHWA, or the County of Hawai`i, will contact the USFWS 30 days prior to controlling weeds around existing endangered plants, so that the USFWS can train workers who will be controlling weeds in the preserve (1) how to identify rare/endangered plants and (2) proper techniques for working in close proximity to these plants. Furthermore, the USFWS may survey the area for additional rare and listed species and mark or flag those individuals; and

16. No heavy equipment (i.e., bulldozers) should be used in any of the undisturbed portions of the dry forest preserve. Bulldozing will diminish the ecological integrity of this relatively pristine area because these areas are more susceptible to weed invasion and the soils and hydrology will be altered.

The USFWS will work with the individuals or agencies that will be controlling invasive plants in the preserve to ensure staff are aware of proper techniques for working in close proximity to listed taxa and are able to identity listed and rare taxa.

For the purposes of the consultation, survival of individual plants equates to survival for at least three years, the third year without supplemental water. However, because of the harsh and variable conditions at the out-planting sites, USFWS's limited horticultural knowledge of these endangered and candidate plants and a scarcity of propagation material, an Implementation Team composed of Hawai'i Forestry Industry Association (HFIA) staff, USFWS staff and other botanists and horticulturalists familiar with dry forest restoration techniques, will be established in order to assist HFIA in adaptively managing the implementation of this project.

4.0 MONITORING PLAN

4.1 Monitoring During Construction

Temporary fences erected during construction will be monitored to prevent accidental damage to endangered plants within the dryland forest preserve.

4.2 Monitoring within the Kaloko Makai Dryland Forest Preserve

Monitoring helps to ensure that the goals and success criteria of the HCP are achieved. Information from monitoring activities and other sources (e.g., research) will be used to evaluate whether the goals and success criteria of the HCP are being achieved.

4.2.1 Preserve Populations

All listed species populations within the Kaloko Makai Dryland Forest Preserve will be monitored by Kaloko Makai contractors. Monitoring of the dryland forest preserve populations will be conducted to determine taxon stability and to track survival, mortality and reproduction.

Data will be collected following the Hawai`i Rare Plant Restoration Group ("HRPRG") rare plant monitoring format. Location information (map and/or GPS coordinates) will be recorded for individuals and/or populations (listed and candidate species) found within the dryland forest preserve:

1. Record reproductive status of all individuals: Record presence of fruit (mature or immature), and flower (buds or opened) and numbers of individuals with each.

2. Collection information: Record any collections made, assign numbers to plants sampled, designate purpose for collection before collecting. This information should follow all propagules throughout its life.

Monitoring will also be conducted to assess the status of the dryland forest preserve relative to control of invasive species (i.e. monitor for presence of ungulates and monitoring weeding activities within 15-foot (ft) buffer of all listed species.)

Additionally, endangered species populations will be monitored for seed collection for planting. Monitoring of the preserve populations of these species will be done to determine phenology and to collect propagules for storage, propagation or experimentation.

Monitoring will help determine the appropriate window when collection of propagules is highly probable which will help to ensure successful seed collection. Monitoring will be adjusted according to phenology patterns for seed collection. Surveys will be done to determine if or when species are flowering and to locate mature individuals from which propagules will be collected (if necessary).

4.2.2 Nothocestrum breviflorum

Monitoring of the *Nothocestrum breviflorum* will be done in the same format as the listed species within the Kaloko Makai dryland forest preserve.

4.2.3 Transplanted Populations

If it is determined that attempted transplanting is feasible, the transplanted populations of *Pleomele hawaiiensis* will be monitored by Kaloko makai contractors to assess the status and stability of the populations, as well as their success. Monitoring of the transplanted plants, as well as propagation and planting methods and an examination of threats, will be conducted to determine progress of plant survival.

During the first 6-months, survival of the plants will be assessed at least three times during the initial period. The next sampling time will be 12-months after seed sowing or planting, and thereafter the plants will be monitored annually.

The results of this monitoring will be used to develop or refine techniques that maximize the survival of individual plants. Additionally, the information will be the basis for determining how many individuals need to be planted if augmentation of the transplanted populations are needed.

Monitoring will be focused on determining survival and growth of all individuals transplanted:

1. Determine survival of plants;
2. Document horticultural methods used for transplanting and
3. Track survival rate of transplanted individuals

The results of monitoring plant growth, relative to the different horticultural treatments, will be used to help predict or refine the results of the plant survival analysis.

Data collection will include the following analysis:

1. Vigor will be recorded for all sampled individuals in the following classes: *healthy* - foliage appears green and vigorous, less than 10% dead leaves or defoliation; *moderate* - some chlorosis of deformity (e.g., curled, extremely small, or insect damage) may be seen in the leaves, 10-50% dead leaves or defoliation; *poor* - most leaves may be dead or chlorotic or deformed; 50% dead leaves or defoliation; *dead* - no live foliage or woody tissue.
2. Phenological stage: Record data if the plant is vegetative, reproductive, or dead.
3. Damage to plants: Any obvious damage to the plants from humans, ungulates, rodents, disease or insects will be identified and recorded when each of the sampled plants is examined and measured.

4.2.4 Planted Populations

The planted populations will be monitored by Kaloko Makai contractors to assess the status and stability of the populations, as well as their success. Monitoring of the planted populations, as well as propagation and planting methods, and an examination of threats, will be conducted to determine progress of plant survival.

During the first 6-months, germination and/or survival of the plants will be assessed at least three times during the initial period. The next sampling time will be 12-months after seed sowing or planting, and thereafter the plants will be monitored annually.

The results of this monitoring will be used to develop or refine techniques that maximize the survival of individual plants. Additionally the information will be the basis for determining how many individuals need to be planted if augmentations of the replacement planting populations are needed.

Monitoring will be focused on determining germination, survival and growth of all replacement planting individuals:

1. Determine germination and/or survival of plants;
2. Document horticultural methods used for propagation and planting (i.e., cuttings, mound layering, seeding, size of pot, etc.) and
3. Track survival rate of planted individuals

The results of monitoring plant growth relative to the different horticultural treatments will be used to help predict or refine the results of the plant survival analysis.

Data collection will include the following analysis:

1. Vigor will be recorded for all sampled individuals in the following classes: *healthy* - foliage appears green and vigorous, less than 10% dead leaves or defoliation; *moderate* - some chlorosis of deformity (e.g., curled, extremely small, or insect damage) may be seen in the leaves, 10-50% dead leaves or defoliation; *poor* - most leaves may be dead or chlorotic or deformed; 50% dead leaves or defoliation; *dead* - no live foliage or woody tissue.
2. Phenological stage: Record data if the plant is vegetative, reproductive, or dead.
3. Damage to plants: Any obvious damage to the plants from humans, ungulates, rodents, disease or insects will be identified and recorded when each of the sampled plants is examined and measured.

4.2.5 Pathogen Monitoring for all populations

A baseline inventory for all species pathogens will be maintained. All populations will be monitored to determine if they are contaminated by new pathogens or other pest species of concern.

4.3 Adaptive Management Options

Adaptive management options to consider include, but are not limited to:

- Increasing or decreasing the number of plants planted and/or transferred into the dryland forest preserve during the initial reintroduction phase
- (Re)introduction or augmentation efforts for a particular population unit
- Intensifying or changing post-planting care (e.g., watering)
- Increasing or decreasing the control of specific threats

Final decisions to change certain management actions will be approved by Kaloko Makai and DLNR-DOFAW. DLNR-DOFAW will determine which actions require additional recommendations by the ESRC.

5.0 HCP IMPLEMENTATION

The table below is a summary of the measures and costs to implement the HCP for the Kaloko Makai Project in 2011 dollars. Costs provided are estimates. Actual costs for items may vary and costs may be adjusted in the future. Cost distribution includes all costs (including funding that Federal Highways and the County of Hawai`i will fund on their Ane Keohokālole Highway project.)

Summary of costs and measures for proposed mitigation activities over 20 year HCP term

Management Entity	Activity	1st Year Initial Costs	Subsequent Annual Costs
Kaloko Makai	Consider transplanting 2-individual *Pleomele hawaiiensis* (hala pepe) from outside the dryland forest preserve into the Kaloko Makai dryland forest preserve (if feasible).	$5,000	
Kaloko Makai	Collect genetic material and propagate so that 6-individuals of *Pleomele hawaiiensis* (hala pepe) survive planting within the Kaloko Makai dryland forest preserve.	$2,000	
Kaloko Makai	Plant enough individuals so that 6-individuals of *Pleomele hawaiiensis* (hala pepe) survive within the Kaloko Makai dryland forest preserve.	$5,000	
FHWA	Collect genetic material and propagate so that 30-individuals of *Nothocestrum breviflorum* (`aiea), *Neraudia ovata* (ma`oloa) and *Caesalpinia kavaiensis* (uhiuhi); and 40-individuals of *Pleomele hawaiiensis* (hala pepe) survive planting within the Kaloko Makai dryland forest preserve.	$10,000	
FHWA	Plant enough individuals so that 30-individuals of *Nothocestrum breviflorum* (`aiea), *Neraudia ovata* (ma`oloa) and *Caesalpinia kavaiensis* (uhiuhi); 40-individuals of *Pleomele hawaiiensis* (hala pepe); and 40-individuals of *Bidens micrantha* ssp. *Ctenophylla* (ko`oko`olau) survive within the Kaloko Makai dryland forest preserve.	$25,000	
FHWA	Control weeds in a 15-ft. buffer around *Nothocestrum breviflorum* (`aiea), *Neraudia ovata* (ma`oloa), *Caesalpinia kavaiensis* (uhiuhi), *Pleomele hawaiiensis* (hala pepe) and *Bidens micrantha spp. ctenophylla* (ko`oko`olau) within the Kaloko Makai dryland forest preserve and existing *Nothocestrum breviflorum* (`aiea) outside of the Kaloko Makai dryland forest preserve.	$20,000	$20,000 (year 2 & 3)
FHWA	Control weeds in the abandoned construction staging area for Hina Lani Street.	$20,000	$10,000 (year 2 & 3)
FHWA	Install a 4-ft. woven mesh fence along the east side of Ane Keohokālole Highway.	$17,000	
FHWA	Control weeds along a 15-ft. buffer of the Ane Keohokālole Highway.	$10,000	$10,000 (year 2 & 3)

Management Entity	Activity	1st Year Initial Costs	Subsequent Annual Costs
Kaloko Makai	Installation of fire response dip tank	$10,000 (year 4)	
Kaloko Makai	Continuation of weed management and control initiated by FHWA within the Kaloko Makai Dryland Forest Preserve (*Nothocestrum breviflorum, Caesalpinia kavaiensis, Neraudia ovata* and *Pleomele hawaiiensis*) and for the existing *Nothocestrum breviflorum* outside of the Kaloko Makai Dryland Forest Preserve.	$10,000 (year 4)	$65,000 (years 5-20)
	Total	**$134,000**	**$1,055,000**
	10-year Total	**$1,189,000**	

As noted previously, after informal consultation with USFWS, Federal Highways is implementing its own mitigation measures addressing impacts of an adjoining road project that are included by reference to the management actions of this HCP. Kaloko Makai is cooperating with the parties associated with the Ane Keohokālole Highway for FHWA activities for certain actions in the Kaloko Makai Dryland Forest Preserve. It is anticipated that FHWA will fund their proposed actions and the above funding estimates associated with the highway project will be provided by Federal Highways and/or others.

5.1 Responsibilities

Kaloko Makai is legally responsible for all aspects of the HCP implementation. In addition, with FHWA funding its own actions, Kaloko Makai shall provide funding sufficient to monitor compliance of the HCP (HRS 195D). Kaloko Makai will deploy personnel or contractors that are qualified and subject to approval by DLNR-DOFAW.

Kaloko Makai recognizes that effective monitoring of potential take resulting from project activities, in compliance with the terms of the HCP is essential. Per HRS 195D, in the event that the Endangered Species Recovery Committee (ESRC) determines, upon annual review, that Kaloko Makai is not in compliance with regard to take monitoring, Kaloko Makai shall provide funding to the state that is sufficient to support personnel and expenses to conduct the monitoring.

The HCP will be administered by a qualified biological specialist contractor (criteria to be developed by Kaloko Makai in cooperation with the state, USFWS, FHWA and Hawai`i County) funded by the parties, as part of this HCP for the Kaloko Makai Project, with additional guidance from the state (pursuant to the implementation of the HCP). Other experts may be consulted as needed, including biologists from other agencies (such as the USFWS), conservation organizations, consultants and academia. HCP-related issues may also be brought before the ESRC for formal consideration when deemed appropriate by Kaloko Makai and the state.

The Applicant or designated biological specialist will meet at least semi-annually with the state. Additional meetings/conferences may be called by any of the parties at any time to address immediate concerns. The purpose of the regular meetings will be to evaluate the efficacy of monitoring methods, compare the results of monitoring to the estimated take, evaluate the success of mitigation, and develop recommendations for future monitoring and mitigation. Regular meetings will also provide opportunities to consider the need for adaptive management measures.

In addition, the Applicant will meet annually with the ESRC to provide updates to monitoring, mitigation, and adaptive management, and to solicit input and recommendations for future efforts. Additional meetings may be requested by the ESRC at any time to address immediate questions or concerns.

Kaloko Makai is responsible for providing the identified funds to implement the mitigation measures expressly described in this HCP. Kaloko Makai, will manage the funds required to cover the costs associated with the HCP mitigation measures and will maintain a detailed report that accounts for the money spent to implement the mitigation activities and will provide annual reports that summarize the results of mitigation and monitoring activities.

Through its biological specialist, Kaloko Makai will provide annual reports to the state that summarize the results of the re-planting and propagation and any take that has occurred.

These reports will also be provided to the ESRC. Kaloko Makai is responsible for implementation of the HCP and actions described in the Project Description and shall have completed its involvement for this project once the stipulations identified in this HCP are fulfilled.

Kaloko Makai will not be responsible for any additional actions or costs that are not identified in the HCP Project Description section, as long as the HCP is properly implemented and functioning. Nor will Kaloko Makai be responsible for the actions that FHWA has agreed to take in their consultation with USFWS.

This HCP is designed to address the authorized take of two listed plant species and one candidate species as well as the preservation of two additional listed species.

The take level requested is 1-*Nothocestrum breviflorum* (`alea), 2-*Pleomele hawaiiensis* (hala pepe) and approximately 40-*Bidens micrantha* spp. *ctenophylla* (ko`oko`olau). Direct take, and associated anticipated indirect take, will be compensated through the mitigation plan.

The HCP also covers two other listed plant species *Neraudia ovate* and *Caesalpinia kavaiensis*. These species will be preserved within the Kaloko Makai dryland forest preserve and no take of these species is anticipated, due to the development of the Kaloko Makai project.

After numerous and extensive surveys focused on identifying endangered species within the Kaloko Makai project, only two listed species (3 individual plants) and one candidate species (40 individual plants) were found outside of the dryland forest preserve. There are numerous endangered species within the dryland forest preserve. Proposed mitigation measures in the HCP include protection of habitat and management of threats to several endangered species including hala pepe, 'aiea, ma'oloa and uhiuhi, as well as the candidate species ko'oko'olau. As a result of this HCP and management measures, an Incidental Take License is requested for the take of all endangered species and candidate species that may be situated within the Kaloko Makai development area.

5.2 HCP Scope and Duration

Kaloko Makai proposes to enter into the HCP to cover the potential take of listed species as a result of the development of Kaloko Makai. The term of the HCP is for a period of 20-years. After 20-years, the HCP may be renewed, amended or extended if mitigation criteria are not met, up to 10-years for a total period of 30-years.

However, this HCP and proposed actions are dependent upon Kaloko Makai receiving all necessary entitlements and permits, and FHWA funding its proposed actions. If necessary entitlements, permits and FHWA funding its actions are not attained and the Kaloko Makai project is unable to move forward, the HCP and actions will not be implemented.

5.3 HCP Monitoring

Monitoring project impacts to the listed plant species will be conducted as described in Section 5.0. Monitoring is required during site grading outside of the Kaloko Makai dryland forest preserve boundary during construction and after construction at both the Kaloko Makai dryland forest preserve and at the site of the one *Nothocestrum breviflorum* tree to ensure that the authorized levels of take are not exceeded, and that the effects of take are minimized and mitigated to the extent possible.

Monitoring and reporting by the Applicant will address both compliance with and effectiveness of monitoring and mitigation measures. Compliance monitoring will verify the Applicant's implementation of the conservation/mitigation measures in the HCP Project Description.

Annual reports and other deliverables as described in the Project Description will be provided to the State to enable verification that the Applicant has performed all of the required activities and tasks on schedule. Monitoring will document take relative to authorized levels and the success of the HCP mitigation program. The monitoring will involve surveys to make sure the authorized level of take is not exceeded, and that minimization and mitigation measures are sufficient and successful.

<u>HCP Reporting</u>
Semi-annual meetings with the state will be held to provide brief progress reports and summarize the mitigation efforts. Written progress reports and electronic copies of HCP-related data will be submitted no less frequently than once per year to the state.

These annual reports will be tied to the state's fiscal schedule such that information from the period July 1 through June 30 will be summarized and submitted no later than August 1 of each year. Take limits will be reviewed and changed circumstances or adaptive management measures will be discussed with the state as appropriate. In addition, an incident report will be submitted to the state within 48-hours of any documented take of Covered Species.

5.4 HCP Project Funding

Sufficient funding will be made available by Kaloko Makai, with FHWA funding its own mitigation actions per informal consultation with USFWS, to ensure that the proposed measures and actions in the HCP are undertaken in accordance with the schedule. The funding provided allows for the costs of the proposed management actions, the options of state compliance monitoring and reporting (in addition to outside contractors and contingency costs for mitigation that could be pursued in the event that propagation and replanting efforts are not as effective as anticipated).

A summary of costs and measures for proposed mitigation activity is presented in section 5.0. Assurance of funding will be provided by bond or other arrangement in compliance with HRS 195D.

5.5 Changed Circumstances Provided for in the HCP

Changed circumstances are circumstances that occur during the life of an HCP that can reasonably be anticipated and planned for and occur independent of the proposed project.
For Kaloko Makai, possible changed circumstances that are anticipated and planned for include:

1. Disease outbreaks in any of the listed species;
2. Hurricanes, fire or other major natural disaster that may affect the project site or dryland forest preserve;
3. Changes in the price of raw materials and labor;
4. The de-listing of any species covered in the HCP; and
5. The listing of one or more species that already occur on site, not currently covered in the HCP.

The procedures to provide for these scenarios are described below:

1) Disease Outbreaks in Listed Species. If an outbreak should occur within the dryland forest preserve, Kaloko Makai will assist the state in implementing measures to prevent or reduce the severity of the outbreaks within the dryland forest preserve as appropriate under the monitoring and reporting budget established for the mitigation expenses.

   Disease is considered one of the lesser threats covered in the HCP. Should the prevalence of disease be identified as a major threat to the survival of the species covered in this HCP, Kaloko Makai will consult with the state to determine if changes in monitoring, reporting or mitigation are necessary to provide assistance in documenting or reducing the impact of disease. Any changes prompted by disease outbreaks in the species covered in the HCP will be performed under the budget established for monitoring and reporting.

2) Natural Disaster. Throughout recorded history, severe storms have occasionally impacted the Hawaiian Islands. The covered plants are not known to be particularly susceptible to habitat destruction from severe storms, but in the event that the Kaloko Makai dryland forest preserve is damaged or plants suffer mortality due to storm activities, Kaloko Makai will contribute to measures to rehabilitate individuals and restore damaged habitat as deemed appropriate by the State and the USFWS.

   The same conditions hold true if a fire were to occur within the dryland forest preserve.

3) Changes in the Price of Raw Materials and Labor. Annual reviews will be performed to analyze the costs in the previous years' budget for mitigation expenses and cumulative costs. Annual expenses for subsequent years will be adjusted to meet projected costs based on the previous years' expenditures and cumulative spend to date.

4) De-listing of Covered Species. Should the species covered in the HCP be de-listed during the tenure of the permit, it is expected that the mitigation efforts provided by Kaloko Makai will contribute to the de-listing of the species. However, mitigation actions for the species will continue to be performed in accordance with the HCP, unless and until the state agree that such actions may be discontinued.

5) Listing of One or More Species that Already Occur on Site. In the event that the species that occur on site are listed pursuant to the ESA, Kaloko Makai will evaluate the degree to which the species is (or are) at risk of being incidentally taken by project operations. If take of the species appears possible, Kaloko Makai will then assess whether the mitigation measures already being implemented provide conservation benefits to the newly listed species and if any additional measures are needed to provide a net benefit to the species. Kaloko Makai would then seek coverage for the newly listed species under an amendment to the HCP.

5.6 Changed Circumstances Not Provided for in the HCP

If changed circumstances occur that are not provided for in Section 5.0 (funding summary) and the HCP is otherwise being properly implemented, the state will not require any conservation and mitigation measures in addition to those provided for in the HCP without the consent of Kaloko Makai. Kaloko Makai would seek re-initiation of formal consultation with the state, as appropriate, pursuant to 50 CFR § 402.16.

5.7 Notice of Unforeseen Circumstances

The state will have the burden of demonstrating that unforeseen circumstances exist, using best available scientific and commercial data. The state will notify Kaloko Makai in writing should the State believe that any unforeseen circumstance has arisen.

5.8 Incidental Take License/Take Permit Duration

This HCP for Kaloko Makai is written in anticipation of the issuance of an Incidental Take License to cover the entire construction and integration period of the project, in addition to subsequent operations, for a total duration of 20-years. After 20-years, the HCP may be renewed, amended or extended if mitigation criteria are not met, up to 10-years for a total period of 30-years.

However, this HCP and proposed actions are dependent upon Kaloko Makai receiving all necessary entitlements and permits, and FHWA funding its proposed actions. If necessary entitlements, permits and FHWA funding its actions are not attained and the Kaloko Makai project is unable to move forward, the HCP and actions will not be implemented.

5.9 HCP Amendment Procedure

Different procedures are present that allow for the amendment to the ITL. However, the cumulative effect of any amendments must not jeopardize any listed species.

Minor Amendments
Minor amendments include routine administrative revisions, time extensions to the ITL, changes to surveying or monitoring protocols that do not decrease the level of mitigation or increase take. A request for a minor amendment to the HCP may be made with written request to the state and implemented upon receiving concurrence from the agencies that the modification provides protection equal to or greater than the level provided by the Project Description. Request for minor amendment should be made no less than 180-days prior to the expiration of the ITL.

Formal Amendments

Formal amendments are required when the Applicant wishes to significantly modify the project, activity, or conservation program already in place or when a net adverse effect on the listed species is significantly different than that considered in the original HCP.

For example, a formal amendment would be required if the documented level of take exceeds that covered by the state's ITL. A formal amendment would also be required if another listed species is found to occur in the project area and could be adversely affected by project activities or in the event of unforeseen circumstances. An amendment to the ITL requires written notification to the state requesting an amendment to the HCP addressing the new circumstance(s). The need for a formal amendment must be determined at least one year before ITL expiration, as a formal amendment may require additional baseline surveys and data collection, additional or modified minimization or mitigation measures, additional or modified monitoring protocols, ESRC, agency, and additional public review, and approval by the BLNR.

5.10 Renewal and Extension of the HCP

This HCP proposed by Kaloko Makai may be renewed or extended, and amended if necessary, beyond its initial term with the approval of the state by minor or formal amendment. A written request will be submitted to the state that will certify that the original information provided is still current and conditions unchanged or provide a description of relevant changes to the implementation of the HCP that will take place. The request will also provide species-specific information concerning the level of take that has occurred during the HCP implementation.

5.11 Other HCP Implementation Measures

An Implementing Agreement stipulating the HCP terms and conditions in contractual form will be signed by Kaloko Makai and the state to provide assurances that the HCP will be implemented.

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APPENDIX A

DRAFT

KALOKO MAKAI DRYLAND FOREST PRESERVE

FIRE MANAGEMENT PLAN

JULY 2011

Executive Summary

Kaloko Makai's objective is to create a Fire Management Plan (FMP) for the Kaloko Makai Dryland Forest Preserve (Preserve) that addresses the specific potential fire issues within and surrounding the Preserve, for inclusion in the Kaloko Makai Dryland Forest Preserve Habitat Conservation Plan.

This FMP will serve as a plan of action to reduce fire risk and increase fire response to the Preserve. The Preserve FMP identifies local fire conditions, fire hazards and fire management resources/assets throughout the surrounding area and serves as a resource for fire management planning. The FMP also identifies and prioritizes areas where fire threat mitigation and management are most necessary.

Kaloko Makai will reduce fire hazards within and surrounding the Preserve using an integrated approach that includes the following elements:

- Fire-prone brush clearing and reduction
- Access/egress improvements for fire management activities
- Fire management resource improvements such as water catchments
- A public wildfire awareness program

The Hawai'i County Fire Department has the responsibility of protecting life and property from fire and multifarious emergencies throughout the County, including the Preserve.

Kaloko Makai has, through this FMP, identified some proactive management steps that may be taken to reduce the risk of fire ignition and uncontrolled spread. The ability to identify areas where cost effective, pre-fire management may be used will minimize resource losses and reduce the cost of uncontrolled fire.

The purpose of this FMP is to develop a Preserve's fire management program to better protect human life, the dryland forest ecosystem, cultural resources and property. This FMP will serve as programmatic direction for all fire management activities.

Stakeholders

Stakeholders are people, individuals or groups who have a high level of interest in the protection of resources from fire around and within the Preserve.

The Preserve will be managed by contractors hired by Kaloko Makai (whom are yet to be determined.) The chosen contractor will have management responsibility and authority over the Preserve. This will include implementation of the FMP and will serve as the point of contact for any fire related event.

The Preserve is surrounded mostly by lands owned by Kaloko Makai, which will be developed into the Kaloko Makai master planned community. A portion of the south-eastern boundary of the Preserve borders private land owned by Lanihau Properties.

The Kaloko Industrial Park, the Kaloko Heights development and the Kaloko-Honokōhau National Historical Park are neighboring properties which may be significantly impacted by fire and smoke, in the event of fire within the Preserve.

The following are primary stakeholder contacts:

Response:

Hawai'i County Fire Department (HCFD) Fire Chief: Darryl J. Oliveira Email: fire@co.hawaii.hi.us	(808) 932-2900 25 Aupuni Street Hilo, HI 96720
Hawai'i County Fire Commission Commissioners: Toby Taniguchi, Chair Scott Stabo, Vice-Chair Laurie Bass Greg Henkel Kimo Lee Byron Moku Luahiwa Namahoe Kaloa Robinson	(808) 961-8317 25 Aupuni Street, Suite 2602 Hilo, HI 96720
Hawai'i County Civil Defense (HCCD) Department Head: Quince Mento Email: civil_defense@co.hawaii.hi.us	(808) 935-0031 920 Ululani Street Hilo, HI 96720

Landowners adjacent to or near the Dryland Forest Preserve:

Kaloko-Honokōhau National Historic Park Superintendent: Kathy Billings Email: kathy_billings@nps.gov	(808) 329-6881 x1201 73-4786 Kanalani Street, #14 Kailua-Kona, HI 96740
Palamanui Palamanui Global Holdings, LLC	(808) 930-2952 72-3977 Queen Ka'ahumanu Hwy Kailua-Kona, HI 96740
Kaloko Industrial Park TSA Corporation	(808) 955-1123 1585 Kapiolani Blvd., Suite 910 Honolulu, Hawaii 96814.

Other Important Stakeholders Include:

Department of Land and Natural Resources (DLNR) Division of Forestry & Wildlife (DOFAW) Hawai'i Protection Forester: Jay Hatayama Email: jhatayama@dofawha.org	(808) 974-422 19 East Kawili Street Hilo, HI 96720
Department of Hawaiian Home Lands (DHHL) Land Management Division Property Development Agent: Mike Robinson Email: mike.e.robinson@hawaii.gov	(808) 922-3480 160 Baker Avenue Hilo, HI 96720

Hawai'i Forest Industry Association
Hawai'i Director: Mike Robinson
Email: mike.e.robinson@hawaii.gov

(808) 933-9411
P.O. Box 66
O'okala, HI 96774

US Fish & Wildlife Service
Field Supervisor: Loyal Mehrhoff
loyal_mehrhoff@fws.gov

(808) 792-9586
300 Ala Moana Blvd., Rm. 3-122
Box 50088
Honolulu, HI 96850

Kaloko Makai Dryland Forest Preserve

SCD - TSA Kaloko Makai, LLC proposes to develop Kaloko Makai, a residential, mixed-use development, on approximately 1,139-acres of undeveloped land in Kaloko and Kohanaiki, North Kona, Hawai`i. Kaloko Makai will be a master planned residential community with supporting commercial, light industrial, educational, recreational, open space uses and their related infrastructure.

The project will entail construction of up to 5,000-new single- and multi-family residential units at low- and medium-densities, centralized commercial and neighborhood retail centers, an array of recreational facilities (e.g. parks, trails, open spaces), urgent care medical facility and hospital, elementary and middle school sites and associated infrastructure (e.g., new roadways, utilities, drainage, wastewater and potable and non-potable water distribution systems).

The Kaloko Makai development is home to one of the largest remaining areas of dryland forest in the Hawaiian Islands. The Kaloko Makai Dryland Forest Preserve is unique in that it has not been heavily impacted by ungulates and has had minimal impact from alien plant species.

The US Fish and Wildlife Service (USFWS) has long recognized the importance of the dryland forest on this site for its unique assemblage of native plants, and indicated their desire to preserve a portion of the property for its botanical value. Thus, Kaloko Makai has preliminary set aside 150-acres within the Kaloko Makai development for the creation of the Preserve.

Because of the rugged `a`ā lava, the vegetation is difficult for feral grazing animals to visit. Over much of the area the trees are separated from each other, and this, combined with the virtual absence of fountain grass, has caused the area to be spared from grazing and wildfires. Consequently, the dryland forest is relatively intact, and was home until recently, at least, to four endangered species: *Nothocestrum breviflorum*, *Neraudia ovata*, *Cyperus fauriei*, and *Pleomele hawaiiensis*.

The most common trees are probably the native species *Diospyros sandwicensis* (lama), *Psydrax odoratum* (alahe`e), *Capparis sandwichiana* (pua pilo), and *Sophora chrysophylla* (mämane).

Other native trees include, *Metrosideros polymorpha* (`ōhi`a lehua), *Reynoldsia sandwicensis* (`ohe), *Myoporum sandwicensis* (naio), and *Dodonaea viscosa* (`a`ali`i). The only alien tree species noted in the Kaloko dryland forest were *Jacaranda mimosifolia* (jacaranda), the Polynesian introduction *Morinda citrifolia* (noni), *Schinus terebinthifolius* (Christmas berry), and *Leucaena leucocephala* (koa haole). The latter two species, especially Christmas berry, sometimes form clumps and in some places dominate the edges of the dryland forest.

The southern boundary of the Kaloko dryland forest was bulldozed as a staging area for the development of Hini Lani Street in and fountain grass is spreading in this disturbed habitat. The ground cover in the dryland forest is very sparse, due to the inhospitable growing conditions. The most common species in this category are *Lantana camara* (lantana), the native vines *Cocculus trilobus* (huehue) and *Ipomoea indica* (koali `awa), *Pennisetum setaceum* (fountain grass), *Nephrolepis multiflora* (hairy sword fern), and an escaped ornamental vine *Lophospermum erubescens* (larger roving sailor).

Overall, this vegetation comprises a good quality dryland forest, based upon the flora and the dominance of native species. The native flora is virtually the same as that found in the list of the native flora on the whole site, with the possible exception of *Heteropogon contortus* (pili), which was found elsewhere on the Kaloko property but not in the Kaloko dryland forest.

Importance of Kaloko Makai Dryland Forest Preserve

Although the Preserve is relatively small in size and at very low elevation and rainfall, the Preserve represents some of the best remaining dryland forest. The Preserve is one of the few remaining parcels of dryland forest that has not been completely overrun by fountain grass and it appears to have escaped from any ungulate pressures, due to the rough nature of the substrate.

Dryland forests are the most impacted ecosystems in the Hawaiian Islands. While 42% of the rain forests in the Hawaiian Islands have been lost, 90% of the dryland forests have been eliminated. The remaining 10% has been heavily degraded by introduced plants and ungulates. The area has remained in such good condition because the substrate is a young lava flow that has acted as a deterrent to cattle, fire and the spread of alien grasses.

Protection of this dryland forest ecosystem is vital for the survival of a four endangered dryland forest plant species: *Neraudia ovata* (ma`oloa), *Nothocestrum breviflorum* (`aiea), *Pleomele hawaiiensis* (hala pepe) and *Caesalpinia kavaiensis* (uhiuhi) and one candidate dryland forest plant species, *Bidens micrantha ssp. ctenophylla* (ko`oko`olau).

Neraudia ovata (ma`oloa) is a sprawling shrub in the nettle family (*Urticaceae*) that does not have stinging hairs. It is found in lowland and montane dryland forests. Previously known from the Kona coast from North Kona and Ka`ū, there are currently two known plants within the Preserve. Alien plants such as Christmas berry, koa haole, and fountain grass; residential development; insects such as spiraling whitefly (*Aleurodicus dispersus)* and reduced reproductive vigor due to the small number of existing individuals are the major threats to this species.

Nothocestrum breviflorum (`aiea) is a stout tree in the tomato family (*Solanaceae*) with soft, sappy wood and dark brown bark. It is found in lowland and montane dryland forests. One known individual of this species occurs on the border of the Preserve. The threats to this species are alien plants such as Christmas berry, fountain grass, lantana (*Lantana camara*), and koa haole (*Leucaena leucocephala*) and residential and recreational development.

Pleomele hawaiiensis (hala pepe) is a small, branching tree in the agave family (*Agavaceae*), with leaves spirally clustered at the tips of branches. It occurs in lowland dryland forests. Historically, it was found only on the island of Hawai`i, ranging from Hualālai to Ka`ū. Approximately 23-plants are currently known within the Preserve. The threats to this species are habitat conversion associated with residential and recreational development; habitat destruction by cattle, pigs, sheep, and goats; fire

(which destroyed a large portion of one Pu`u Wa`awa`a population in 1986); competition from alien plants such fountain grass, koa haole, Christmas berry, and lantana; and the lack of reproduction in all but two populations.

Caesalpinia kavaiensis (uhiuhi) is a member of the pea family (*Fabaceae*). It occurs in lowland dryland forests and the wood was traditionally used to make spears and daggers, as well as fishing lures. Its numbers have more recently declined as a result of grazing by introduced cattle, goats and sheep. One plant is found within the Preserve.

Bidens micrantha ssp. ctenophylla (ko`oko`olau) is a tall, perennial herb in the aster family (*Asteraceae*) with bright yellow daisy-like flowering heads. This species is found only in dryland forests of the North Kona region. There are about 100-individuals in the Preserve. Ko`oko`olau are threatened by the alien plant species Christmas berry, fountain grass, and silk oak (*Grevillea robusta*); fire and residential and commercial development. This species is a candidate for listing.

Kaloko Makai Dryland Forest Preserve Fire Management Unit

A Fire Management Unit (FMU) is "a unique land management area defined by land objectives, topographic features, values to be protected, political boundaries, fuel types, or major fire regimes."

The Kaloko Makai Dryland Forest Preserve will be treated as one FMU. The size, vegetation, fuel concerns, management goals and suggested fire management strategies/activities in this FMP are applicable for the entire unit.

Fire Management Unit Characteristics

Location:
Kaloko Makai Dryland Forest Preserve is located on the west side of the island of Hawaii, along the Kona Coast, approximately three miles south of the Keahole Airport and 3.5-miles north of the town of Kailua-Kona.

Climate:
A warm sub-tropical weather pattern is common for the area, with periodic rains and periods of drought. Clouds that do form inland usually disperse before they reach the park.

Fire Season:
Fire season is regarded as year long. The existing amount of fuels and the fact that drought periods can and have occurred anytime during a calendar year, provide a situation where a fire start could ignite, quickly build heat intensity and spread any day of the year. The amount of moisture for this area (20 inches annual average rainfall), contributes to this possibility.

Mean annual temperature is about 80 degrees Fahrenheit. Summer temperatures are slightly higher. Annual precipitation at the airport averages near 20 inches. Average daily minimum and maximum relative humidity ranges from 44% in November to 87% in July.

Fire History:
No fires have been recorded in this Preserve area in recent years. Past fire history can only be speculated.

Fire Hazard Assessments

There are several important issues that define the Preserve's fire hazard level. The Preserve is vulnerable to fire due to the following:

- Fire-prone shrubland and grasses;
- Threat of fire spread to or from adjacent properties/sensitive resources;
- Limited access in the form of ingress/egress routes in the event of fire;
- Lack of reliable water sources for firefighting;
- Public unawareness of the threat of fire within the Preserve

Assets at Risk Assessment

Assets at risk are valued resources that can be damaged or destroyed by fire. In addition to citizen and firefighter safety, the Preserve following assets warrant consideration in pre-fire planning:

- Degradation of native dryland forest
- Destruction of cultural and historic areas
- Damage to facilities and structures
- Possible negative fire effects on watershed
- Pollution and reduced air quality

Hazard Assessment using Fuels, Slope, and Aspect

In addition to weather and the effect that seasons have on plant moisture levels there are three fixed variables that affect fire behavior: fuels, slope and aspect.

Fuels: The Preserve is comprised of flammable vegetation. In addition, a majority of the surrounding properties are dominated by Fountain Grass, Leucaena Scrub, Christmas Berry Scrub, Koa Haole and various other grasses. This type of vegetation can be extremely flammable and susceptible to fire.

Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity and from occasional lightning strikes, they are not adapted to recurring fire regimes and are unable to recover well following a fire.

Alien plants are often better adapted to fire than native plant species and some fire-adapted grasses have become widespread in Hawai`i. Native shrubland and dryland forest can thus be converted to land dominated by alien grasses. The presence of such species in Hawaiian ecosystems greatly increases the intensity, extent and frequency of fire, especially during drier months or drought.

Slope: Slope is a measurement of hillside steepness in percent. With all other factors constant fires burn more rapidly on steep hillsides than on flat ground. Steeper hillsides expose upslope vegetation to heating by radiation and convectional heat currents that dries out the fuel and preheats it. Combustion is quick and more intense than in flat areas. Therefore, increased slope contributes to a more rapid rate of fire spread. Steeper slopes can also lead to increases in wind speed, which in turn increase rate of spread.

The Preserve occupies an area of slope, ranging from 5 to 8 percent. The site has a generally irregular surface with localized mounds and depressions throughout, as is characteristic of non-eroded lava flows.

Aspect: Aspect is the hillside cardinal direction comparable to a compass. In northern latitudes, south-facing hillsides receive more direct sunlight during the day relative to north-facing slopes. Therefore, south facing hillsides are at an elevated temperature and less heat energy is required for ignition to occur and fires to sustain themselves. The Kaloko Makai Dryland Forest Preserve rests on the lower western slope of Hualālai, a dormant shield-type volcano.

Combining Fire Management Resources and Hazards

Assessments of fire management resources and fire hazards within the wildland-urban interface were combined and evaluated in this Fire Management Plan to identify areas of high priority for treatment.

Recommended Plan of Action

The Preserve's FMP takes steps to reduce and mitigate fire hazards to protect public health, on and off site structures, and sensitive resources using an integrated and proactive management approach. The FMP attempts to use a cost effective mix of fire prevention strategies (activities) including the following:

- Identify current and future fire management resources
- Reduce fire-prone shrubs and other hazardous fuels
- Access/Fire Management Resource Improvements
- Fire Awareness and Education

Identify Current and Future Fire Management Resources
The current and future fire management resources identified below will be used in pre-suppression planning and/or in the event of fire, to identify management resources.

Administration
As stated above, the Preserve will be managed by a yet-to-be-determined contractor which will have management of day-to-day activities within the Preserve. Management of the Preserve will be mainly weed control, native plant assessment and monitoring. However, there are actions which management can take to help reduce the Preserves fire hazards, mainly integrating fire management with all other aspects of preserve management.

Managers will ensure equipment operators (or contractors) use fire prevention devices (i.e., spark arrestor) on all field equipment. Structures will be evaluated for flammable construction materials and the need for hazardous fuel reduction work.

County of Hawaii Fire Department
The Kaloko Makai Fire Management Plan will be provided to the County of Hawaii Fire Department to assist them in protecting the Dryland Forest Preserve from fire. Additionally, this fire plan will inform them of the fragile ecosystem and resources contained within the Dryland Forest Preserve and encourage whenever possible to use suppression methods/tactics which are least damaging to resources and the environment.

Once the Kaloko Makai Dryland Forest Preserve has been surveyed, known listed and candidate species will be marked with permanent stakes and mapped to a GIS layer.

A map showing these species, as well as water sources and emergency vehicle entrances will be made available to County agencies, including the Fire Department and will be undated regularly as more resources (water, etc) are developed and made available.

The two nearest County fire stations are the Kailua-Kona and Makalei (to be completed) Stations. The Makalei Station is located in Makalei, North Kona mauka of Makalei Drive and Māmalahoa Highway, between mile marker 32 and 33. The Kailua-Kona Fire Station is located near the intersection of Palani Avenue and Queen Ka'ahumanu Highway. This station serves areas within a 30-mile radius, from Keauhou to the Kona Village Resort.

Kaloko-Honokōhau National Historical Park
The Kaloko-Honokōhau National Historical Park installed a Remote Automated Weather Station (RAWS) in 2005 for daily observations and to determine the various indices in accordance with the National Fire Danger Rating System (NFDRS). Fire danger for the Park is determined daily from the fire weather forecast. An accurate impression of existing fire danger can be determined based on weather data available from the station posted hourly. Because of the proximity of the Park to the Preserve, coordination between the Park and the Preserve when extreme fire danger is high will be very beneficial. Preserve management will work with the Park on having this information available for fire management.

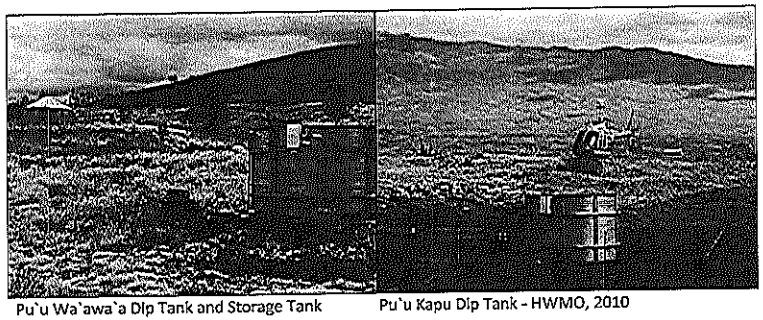
Water Resources
There are two water tanks in the vicinity of the Preserve. With the development of housing along the Preserve's border, more water resources will become available including water tanks, 2-inch outlets to allow fire engine hookup near roadways, fire hydrants, etc.

Kaloko Makai was asked by the County Fire Department for a parcel of land for the potential development of a new fire station (with attached police sub-station). The site is shown on the map below. The development of a fire station in close proximity to the Preserve will be a very valuable asset to the Preserve and enable a much quicker response time. The site could also have a helipad for helicopter landing which would assist in the use of helicopters in firefighting efforts within the Preserve.

The Hawai'i County Fire Department may utilize helicopter support during fire operations which will be governed by their policies, procedures and designated landing areas. Helicopters will not land in the Preserve except for emergency landings.

Kaloko Makai will install a helicopter dip tank within the Preserve. It will be placed in the previously graded portion of land within the preserve where the staging and propagation area for management actions will be within the Preserve.

Dip tanks decrease the travel time required between bucket drops of water during a fire, and, most importantly, can allow first responders to more quickly respond to a fire in the first hour, which can be the difference between a 100-acre or several thousand acre fire. Below are photos of tanks that have been installed at Pu'u Kapu near Waimea and at Pu`u Wa`awa`a, which helps to protect endangered dryland forests.



Pu`u Wa`awa`a Dip Tank and Storage Tank  Pu`u Kapu Dip Tank - HWMO, 2010

Roads

The Dryland Forest Preserve borders Hina Lani Street to the west and the Ane Keohokalole Highway (which is currently under construction) to the south. Both roads are main thoroughfares which makes accessing the western and northern boundaries of the Preserve relatively easy. However, there are no roads and limited formal trails within the Preserve. As the Preserve is managed, and management actions such as weeding and plantings are accomplished, trails will be made to access endangered plants. These trails could be used if necessary for accessing the Preserve for fire management. No interim road are anticipated.

Structures

The Kaloko Makai development around the Preserve will enact fire prevention measures including access roads in accordance with Uniform Fire Code (UFC) Section 10.207, water supply for fire suppression in accordance with UFC Section 10.301(c), and buildings under construction in compliance with the provisions of UFC Article 87.

There is concern that with increased alien and shrub fuels over the Preserve's landscape and with increased human impact, fire occurrence may increase.

The potential ignition sources for fires near the Preserve are accidental ignitions from careless smoking, misuse of fireworks and intentionally-set arson fires. Additionally, with backyards fronting the preserve, use of fire pits, barbeques and other sources of fire increase the chance that fire may affect Preserve.

Kaloko Makai has planned single-family uses adjoining the Preserve. It is believed that this use has less risk, compared to multi-family or commercial uses. Since the Preserve will border housing developments, building setbacks will be developed to keep housing an appropriate distance from the Preserve.

The surrounding Kaloko Makai development will reduce the probability of wildfires on site by replacing the current invasive vegetation with buildings and structures. Additionally, landscaping will incorporate native species and appropriate landscaping will also be employed within the housing developments that can act as barriers if fire was to occur.

Additionally, appropriate signage will be developed to encourage public cooperation and discourage trespassing, vandalism or arson.

Reduce Fire-Prone Shrubs and Other Hazardous Fuels

Today's environment within the Preserve continues its adaptation with the potential of more frequent, low – moderate intensity surface fires. With the onset of Western Civilization, native flora has gradually given way to a more fire climax community of exotic vegetation supporting increased fuel loads and flammability. Today's fuel situation has a greater biomass (loading) of both fine size and larger size fuels which are more easily ignited, quickly develop heat intensity and facilitate quick rates of spread.

A major change in wildland fuels existing today are non-native plants that have flourished, particularly kiawe or mesquite, koa haole and fountain grass. Fountain grass serves as the primary fine fuels for sustaining fire spread. These non-native species seem to dominate a majority of the Preserve and surrounding area where there is favorable soil for plant establishment.

Both kiawe and koa haole have been observed to sprout vigorously after fires that have occurred in other native dryland forests. Fountain grass appears to be a vigorous post burn competitor. The growth form of this plant is a robust bunchgrass, which ultimately results in a high fine fuel loading, easily receptive for an ignition that can spread quickly with high heat intensity.

The possibility exists that, if left unchecked, these alien species will continue to expand their range throughout the Preserve, thereby lessening the opportunity for restoration of native species.

Management of fuels is critical in terms of fire behavior and possible resource damage that could result from a fire incident, and in achieving a particular species composition for ecosystem management. The importance of intentionally managing the wildland fuels in order for a successful fire management program includes identifying, managing, and reducing where appropriate, accumulations of hazardous fuels.

Areas comprised of fire-prone trees or shrubs are especially hazardous as these fires are more intense and cause more extensive damage to resources when fire occurs.

Within the Preserve the most hazardous fuel type has been identified as fountain grass and other non-native grasses. An aggressive program of reducing the presence of grass within Preserve will continue to reduce the area of land at risk from intensive grass fires.

The table below, from the Kaloko-Honokōhau NHP Fire Plan compares the fire potential behavior between native and alien grasses.

Fire Behavior Potential*

Fuel Model	Flame Length	ROS	Comments
1	4 feet	78 ch/hr	Native grasses
3	12 feet	104 ch/hr	Existing alien grasses

*Comparison of potential fire behavior between native and alien grasses based on representative 90% weather parameters of 8% fire fuel moisture and 5 m.p.h. wind speed.

The major goal of the fuel management strategy is to achieve and maintain a fuel level that facilitates protection of life, property, natural and cultural resources, and helps establish a healthy ecosystem.

Invasive species removal will be one of the top priorities within the Preserve. Herbicide and hand clearing is expected to be used to help control populations of alien plants as a part of the invasive plant eradication program and hazardous fuel reduction. Exotic grasses and shrubs may be treated with non-restricted use herbicide and stumps of larger shrubs and trees may be treated and left in place to decay. Downed debris from trees will be regularly removed by hand from accessible areas around the Preserve perimeter.

Weeds will be controlled in a 15-foot (5-meter) buffer around existing and/or planted endangered and candidate species within the Preserve.

Likewise, weeds will be controlled in a 15-foot (5-meter) buffer around the existing `aiea (*Nothocestrum breviflorum)* which lies just outside of the Preserve boundary.

Weeds will be controlled in the abandoned construction staging area for Hina Lani Street and along a 15-foot (5-meter) buffer of the Ane Keohokālole Highway.

A protocol will be developed to avoid introduction of invasive plant species by imported nursery stock, worker shoes, clothing, tools and other sources.

Monitoring of pre- and post-weeding conditions and costs will be documented for overall program evaluation and future planning. Monitoring will also allow managers to evaluate fuel levels because an extended period of above average rainfall could increase fuel levels sufficiently to present a fire threat.

Access/Fire Management Resource Improvements

The Dryland Forest Preserve borders Hina Lani Street to the north and the Ane Keohokalole Highway (which is currently being built) to the west. Both roads are main thoroughfares which makes accessing the western and southern boundary of the Preserve relatively easy. However, there are no roads or formal trails within the Preserve. As the Preserve is managed, and management actions such as weeding and plantings are accomplished, trails will be made to access endangered plants. These trails could be used if necessary for accessing the Preserve for fire management.

Eventually with the Preserve being bisected with management trails, these trails can serve as additional control points in the event of a wildfire and can be used as firebreaks if necessary.

Controlling weeds along a 15-foot (5-meter) buffer of the Ane Keohokālole Highway will aid in the suppression of fires and reduce the spread of grass seed via vehicular traffic.

Because of the Preserves limited access, the development of dip tanks within the Preserve, as described previously, will aid in fire suppression efforts as well.

Fire Awareness and Education

Fire awareness and education activities are aimed at changing people's behavior by awareness and knowledge.

Educational activities will focus on educating those working in the Preserve and adjacent landowners about fire prevention regulations, appropriate prevention activities and current fire danger ratings using signage and outreach activities.

Additionally, fire prevention education will be focused toward Preserve contractors and construction contractors working adjacent to the Preserve so it can be integrated into their jobs and appropriate fire prevention messages developed for properties adjacent to the Park.

Outreach activities could include:

- Use of signs, posters and notices as a means of public education.
- Issuance of warnings to the public, particularly during periods of high fire danger, through public service announcements (radio).
- Work with with local Interagency Fire Prevention Committee.
- Ensure fire prevention awareness is included in dialogue with Preserve neighbors.
- Improve fire awareness levels for those who use neighboring roads or live and work in the vicinity of the preserve to increase overall awareness of the wildland/urban interface fire hazard issues that affect area residents.
- Educate employees and the public about the scope and effect of fire management, including fuels management and resource protection.

Emergency Rehabilitation and Restoration

Although this Fire Management Plan is designed to mitigate the Preserve's susceptibility to fire, it also addresses response management actions if a fire does take place within the Preserve and restoration after a fire event.

Thus, rehabilitation actions need to be considered with every fire management activity. The following apply to the short and long term rehabilitation guidelines and procedures for impacts caused by (1) fire suppression activities and (2) the fire.

There are three components to the emergency stabilization and rehabilitation program: Suppression Damage Repair, Burned Area Emergency Rehabilitation and Restoration

<u>Suppression Damage Repair</u>
Assess and implement actions to rehabilitate natural resource, environmental, or cultural damage caused by suppression activities. The primary purpose is to leave the fire suppression damaged area(s) as natural appearing as possible.

<u>Burned Area Emergency Rehabilitation</u>
Natural re-vegetation is desired and should be allowed to occur. Natural regeneration of ground cover after fires may be satisfactory to ensure adequate protection of soils, although some are undesired alien

species. Special consideration needs to be taken for burned areas. Appropriate mitigating measures, including possible seeding, may be necessary to ensure control of undesired plants do not occur.

Restoration

Restoration activities are long-term ecosystem restoration actions to mitigate impacts from the fire and are generally conducted 3 or more years after the fire.

FIRES, DEATHS, AND LOSSES REPORTED BY COUNTY FIRE DEPARTMENTS: 2000 TO 2008
(Fiscal year ending June 30)

Year	Statewide	Hawaii County
Number of fires:		
2000	4,049	558
2001	4,304	637
2002	4,435	904
2003	5,028	1,166
2004	4,746	782
2005	4,297	887
2006	5,429	897
2007	5,060	927
2008	4,148	892
Fire deaths:		
2000	3	1
2001	3	-
2002	4	-
2003	3	1
2004	8	1
2005	10	-
2006	4	-
2007	6	1
2008	6	-
Fire losses ($1,000):		
2000 1/	20,860	5,302
2001	19,268	4,094
2002	16,214	4,212
2003	17,913	3,343
2004	37,357	15,146
2005	39,436	2,847
2006	38,621	9,167
2007	32,402	8,348
2008	28,005	6,775

Source: Hawaii State Department of Business, Economic Development & Tourism, Website: http://www.hawaii.gov/dbedt/

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APPENDIX B

DRAFT

KALOKO MAKAI DRYLAND FOREST PRESERVE

WEED MANAGEMENT PLAN

JULY 2011

Introduction

Alien plant invasions have become a large problem for land managers throughout the world. In many tropical island ecosystems, introduced plant species have displaced native taxa. Mechanisms of displacement are complex and poorly understood. Many are currently invading extensive dryland habitats on the island of Hawai'i, including the Kaloko Makai Dryland Forest Preserve (Preserve.) By altering species composition and community structure, these alien species interfere with major ecosystem processes such as native plant regeneration, succession and fire frequency. The survival of the endangered and candidate species within the Preserve and their habitat are directly threatened by these alien invaders.

Target Species

The most damaging invasive species to the Preserve and to the survival of the listed ma'oloa (*Neraudia ovata*), 'alea (*Nothocestrum breviflorum*), hala pepe (*Pleomele hawaiiensis*), uhiuhi (*Caesalpinia kavaiensis*) and the candidate species ko'oko'olau (*Bidens micrantha ssp. Ctenophylla)* is fountain grass (*Pennisetum setacecum*).

This species will be the main focus of the Preserve's weed management plan. However, other invasive weed species within the Preserve pose a threat to listed and candidate species including koa haole, Christmas berry and lantana.

Fountain Grass (*Pennisetum setacecum*)
Fountain grass, native to North Africa, was introduced to Hawai'i probably near the turn of the century as an ornamental and its spread has probably been facilitated by its use as an ornamental. It is highly invasive and competes with native species for water, nutrients and space. It alters ecosystems by forming a nearly complete ground cover, causing a dramatic alteration of fire regime.

It is well adapted to fire, and plants re-grow rapidly after a fire. Fountain grass is a fire-tolerant and fire-promoting species. The increased fuel load from tinder-dry fountain grass foliage increases the intensity and spread of fires, resulting in severe damage to desirable vegetation. It accumulates large volumes of dead biomass and burns with high fire intensity. It also establishes itself rapidly after fire by vigorous re-sprouting and apparently by seedling recruitment. As a result, fire favors the establishment of dense to mono-specific stands of fountain grass.

Fountain grass has become a damaging invasive weed within dryland forests in Hawai'i. Dense colonies crowd out other species and are difficult to control. The thick infestations of fountain grass also interfere with efforts to restore native plant species. Adapted to harsh conditions, it thrives on lava flows, exposed subsoil, fire-prone areas and droughty climatic zones. Fountain grass is one of the few alien plants to invade young lava flows and disrupt primary succession at an early stage.

Seed spreads fountain grass. The spikelets have bristles, and are spread in late spring by wind, water, human activities, and by sticking to animals. Seeds will survive in the soil for as long as seven years, and individual plants may live 20 years or more.

Fountain Grass has the greatest distribution and density of any alien plant species within the Preserve. It is by far the greatest threat to listed and candidate species within the Preserve, as well as the Preserve's ecosystems.

Past and Current Control Strategies

Hawai'i Volcanoes National Park - The most intensive fountain grass control program is at Hawai'i Volcanoes National Park. Control work started in the early 1970s in dense populations at the core of the 20,000-acre infestation. By 1985, control of the core areas was abandoned in favor of control of satellite populations and roadsides. Manual control was used, with searching done from helicopter, horseback, and on foot. Using the approach of starting with satellite populations, the expansion of fountain grass in the Park has been stopped. Almost all outlying populations were eradicated after 1-3 control efforts, and these areas are largely searched now from the air. The program now emphasizes control of the dense populations at the center of the infestation, using Velpar (HEXAZINONE).

Linda Pratt and Greg Santos at Hawai'i Volcanoes National Park investigated three pre-emergent/post-emergent herbicides on control of fountain grass at approximately 700 ft elevation in moderately dense stands. They tested Velpar, wettable poweder of Hyvar X (BROMACIL) and Arsenal (IMAZAPYR). They concluded that fountain grass is not sensitive to Hyvar X or Arsenal, with little pre-emergent or post-emergent response at rates tested. However, Velpar at 9 lbs AI/AC produced 100% kill and complete pre-emergent activity for 12 months, with some seedling recruitment by 18 months.

The effects on native plants were investigated rigorously at Hawai'i Volcanoes National Park. Of particular concern was the impact of Velpar. Pratt and Santos found that Velpar did not have a long term effect on pili grass (*Heteropogon contortus*).

Managers have modified research results in the field and tried new chemicals. Chris Zimmer also at Hawai'i Volcanoes National Park, largely uses manual control on isolated plants and 10% Velpar in dense fountain grass stands with over 9 months of pre-emergent activity. The soil is also sprayed around the base of the plants. Five percent Velpar is effective as a post-emergent. Velpar can be used effectively on dormant plants, but is never used around native woody plants because they have observed unfavorable effects. Zimmer found that 2% Roundup is very effective only if the plants are actively growing.

Ka'ūpūlehu - There has also been success at Ka'upulehu-Kona in controlling a mono-specific stand of fountain grass in the understory of six acres of dry forest leased by National Tropical Botanical Garden and in separate plots in nearby private lands. Control was effected with herbicides and seedling recruitment declined considerably. There are also some signs of native tree recruitment. These experiments suggest that control of dense fountain grass stands is feasible for small, highly significant biological sites.

At Ka'ūpūlehu, a 1.5% solution of Fusilade (FUAZIPOP), a highly selective post-emergence grass killer, was effective in controlling fountain grass that was re-sprouting from weed-whacking or on seedlings. Fusilade was used to avoid damage to non-target native trees. Stands were largely reduced to scattered seedling recruitment after three applications. Managers have replaced Fusilade with the more cost-effective Roundup (GLYPHOSATE) at a rate of 1.5-2 percent).

Pōhakuloa Training Area (PTA) - At Pōhakuloa Training Area (PTA), Mick Castillo and Carlo Popolizio are conducting a complex factorial experiment on fountain grass control. They are working in an actively growing mono-specific strand of fountain grass re-sprouting after fire at Pōhakuloa. They used two concentrations of Roundup 1.5% and 3%, Garlon (TRICLOPYR) at 0.5%, Velpar at 2kg/ha and manual control. They tried them separately and in combination.

They provisionally concluded that manual removal, immediately followed by Roundup at both concentrations, applied to soil surface and plant remains, was the most effective post-emergent treatment. They have not evaluated effects of their treatments on pre-emergent control.

University of Hawai'i - James Leary, PhD, an Assistant Specialist in Invasive Weed Management at the Department of Natural Resources and Environmental Management at the University of Hawai'i at Manoa has also had success controlling fountain grass. Leary has found that the active ingredients Arsenal and Roundup are highly effective as foliar spot applications soon after clump green up. He has also found Arsenal to have better residual activity than Roundup and is also much more effective when the plant is dormant. He further suggests incorporating strategic physical removal techniques around sensitive plant occupants as a fire mitigation strategy.

Leucaena leucocephala (koa haole)

This thornless tree forms dense thickets, excluding all other plants. It spreads rampantly and regenerates rapidly from basal shoots after fire. A native to tropical America, koa haole is common throughout Hawai'i in dry to moist areas. It can forms dense stands in dry to mesic pastures and forests and is found on all islands, having been deliberately broadcast over lowland habitats approximately 50 years ago.

Past and Current Control Strategies

Mt. Ka'ala Natural Area Reserve – Management actions included manually pulling the plants up by their roots. Large plants were cut off as close as possible to ground level and the stump treated with Roundup. Monitoring was done in 6 month intervals.

Christmas berry (*Schinus terebinthifolius*)

A native of Argentina, Brazil and Paraguay, this attractive ornamental, has been introduced to subtropical areas worldwide. It has become widespread and grows densely in drier mesic pastures and forests in Hawai'i.

The low-growing, evergreen, deciduous tree is an aggressive invader. It shades out other plants, as well as preventing reestablishment of other species due to the release of allelopathic substances. The fruit is especially favored by alien frugivorous birds. It is killed by high intensity fires but regenerates rapidly where there is a large seed bank.

Past and Current Control Strategies

University of Hawai'i - James Leary, PhD, an Assistant Specialist in Invasive Weed Management at the Department of Natural Resources and Environmental Management at the University of Hawai'i at Manoa is currently working with the EPA on the validity of a technique using aminopyralid and aminocyclopyrachlor.

Hawai'i Volcanoes National Park - HAVO staff (Chris Zimmer) reported control with triclopyr ester at 5% of product in diesel oil applied to basal bark. Good control was achieved with high-volume foliar application of a 1% solution of triclopyramine product.

Ka'ūpūlehu – At Ka'ūpūlehu, Christmas berry has been considered for removal. However, it will be controlled only after native seedlings have established in their shade. Management efforts include girding and treating plants with Garlon to prevent re-sprouting, and removing wood and branches to reduce risk of fire.

Lantana (Lantana camara)
Lantana is an escaped ornamental originally from the West Indies and is now a tropical and subtropical weed of pastures, and forests, across the Hawaiian Islands. It forms dense impenetrable stands in dry and mesic pastures and forests, crowding out native plants and forage grasses.

Past and Current Control Strategies
Ka'ūpūlehu – At Ka'ūpūlehu, lantana has been considered for removal. However, lantana will be controlled only after native seedlings have established in their shade. Management efforts include girding and treating plants with Garlon to prevent re-sprouting, and removing wood and branches to reduce risk of fire.

Kaloko Makai Dryland Forest Preserve Invasive Weed Control Management Actions
Kaloko Makai (in cooperation and coordination with the County of Hawai'i and FHWA) will manage the Kaloko Makai Dryland Forest Preserve as a 150-acre preserve. Management will be contracted to an entity with experience in dryland forest restoration and conservation.

A previously graded portion of land within the preserve will be used as a staging and propagation area for management actions within Preserve. The staging area will serve as a central site for a variety of activities including storage of equipment for weeding activities.

The Federal Highways Administration (FHWA) is using the Kaloko Makai Dryland Forest Preserve as an out-planting area for mitigation measures related to the development of Ane Keohokālole Highway. Some of their management actions include weeding and invasive species control.

FHWA has agreed to control weeds in a 15-foot (5-meter) buffer around existing and/or planted *Nothocestrum breviflorum, Caesalpinia kavaiensis, Neraudia ovata, Pleomele hawaiiensis* and *Bidens micrantha spp. ctenophylla* within Preserve. FHWA will control weeds in a 15-foot (5-meter) buffer around the existing *Nothocestrum breviflorum* outside of the Preserve.

FHWA has also agreed to controlled weeds in the abandoned construction staging area for Hina Lani Street and along a 15-foot (5-meter) buffer of the Ane Keohokālole Highway. FHWA management measures, including weeding control activities, will run for three years.

Kaloko Makai will continue weed control activities initiated by FHWA, after the first three-years of FHWA management and after land use entitlements are granted for the proposed development.

Therefore, this weed management plan details Kaloko Makai's weeding actions following FHWA's weed management actions. Management actions to control weeds within the Preserve will consist of a variety of approaches, with the specifics varying depending upon the species.

Weed Control Around Existing Threatened and Candidate Species
Once the Kaloko Makai Dryland Forest Preserve has been surveyed, known listed and candidate species will be marked with permanent stakes and mapped to a GIS layer (this is expected to be completed by the Contractor for the County and FHWA.)

First and foremost, fountain grass will be controlled within a 15-foot (5-meter) buffer around existing listed and candidate species within the preserve. Weed control around these plant species will be done to reduce competition and enhance the possibility of natural recruitment.

Using the successful management actions at Ka'ūpūlehu described by Susan Cordell in her report "Simple and Cost-Effective Methods Control Fountain Grass in Dry Forests (Hawai'i)", a combination of manual and chemical control will be used for eradicating fountain grass within the 15-foot buffer. This combination has been shown to be most effective for controlling and eliminating fountain grass, which is the most prolific weed within the 15-foot buffer of the listed species.

The fountain grass plants will first be cut back. Control requires the manual or mechanical removal of the dead and/or dormant portions of the plant. Weeds will be manually removed within one meter of a listed plant and beyond one meter weeds will be mechanically controlled using gas-powered weed trimmers (weed whackers), or by hand, depending upon the terrain.

Once new growth emerges, the fountain grass will be sprayed with herbicide. The amount and type of chemical used will be further refined once management begins. As described in the "Past and Current Control Strategies" section of this plan, numerous entities have used and had success with various levels and types of chemicals. Using past experience as a guide, Preserve management will experiment to determine what will work best within the dryland forest ecosystem. However, based on the success by Susan Cordell at Ka'ūpūlehu, it seems that Glyphosatebased herbicide (Roundup® at a rate of 1.5-2 percent), currently is the best and most cost effective herbicide for fountain grass control within a dryland forest.

This technique has been found to be most effective during the active growth stage of fountain grass, which appears to be related to rainfall and is not necessarily seasonal. Three or four subsequent applications over a three to four month period will be required to effectively eliminate any new growth, per Cordell.

Once fountain grass has been eradicated from the 15-foot buffer, fountain grass will continue to be controlled by spot herbicide application and/or hand pulling approximately two times each year.

Little has been documented regarding the control of Christmas berry, Lantana and Koa Haole within dryland forests. However, based on the Hawai'i Forest Industry Association's work at Ka'ūpūlehu, these species will be controlled only after native seedlings have established in their shade. These species will be girdled and treated with Garlon to prevent re-sprouting and wood and branches will be removed to reduce risk of fire.

Adaptive management techniques will be used to assess what control methods are best for preserving both the listed and candidate species, as well as the ecosystem of the Preserve.

'aiea exclosure
A small-scale exclosure will be used to provide for the protection of the individual 'aiea. The exclosure will be of sufficient size, 15-foot (5-meter), to include the plant's habitat. A variety of materials may be used for the exclosure including plastic construction fencing, hogwire or concertina wire. Posts may include; T-posts, form stakes and metal conduit, or dead tree branches. Fountain grass will be controlled within a 15-foot (5-meter) buffer around the existing *Nothocestrum breviflorum*, outside of the Preserve. Weed management will be the same as is done within the Preserve.

Control Weeds Along Roadway
Weeds will be controlled along a 15-ft (5-m) buffer of the Ane Keohokalole Highway. The removal of this periphery population will create a buffer zone along the Preserve and Highway. This periphery

infestation can be surveyed systematically on an annual basis. The intent is that, as control of this population occurs, control efforts will be extended toward the center of the infestations. Research has shown that control of outlying populations and creation of buffer zones is a very effective approach.

Other Protocols

Thirty days prior to controlling weeds around existing endangered plants, DLNR-DOFAW and USFWS will be notified so that workers who will be controlling weeds in the Preserve can be briefed on (1) how to identify rare/endangered plants and (2) proper techniques for working in close proximity to these plants.

A protocol will be developed to avoid introduction of invasive plant species by imported nursery stock, worker shoes, clothing, tools and other sources. The details of such protocols will be developed by the contractors chosen to implement management actions within the Preserve.

Other Invasive Species

The Preserve is home to other introduced invasive weed species as well. These species, although they do not pose an immediate threat to the listed species within the forest, may still present a problem if they continue to spread. Thus, they will be monitored and removed within the 15-foot buffer areas, as management deems necessary. These species include:

- Digitaria ciliaris (large crabgrass)
- Rhynchelytrum repens (Natal redtop)
- Tridax procumbens (coat buttons)
- Chamaesyce hirta (garden spurge)
- Chamaesyce hyssopifolia (hyssop-leaf sandmat)
- *Desmodium tortuosum* (Florida beggarweed)
- Macroptilium lathyroides (cow pea)
- Boerhavia coccinea (hogweed)
- Sida rhombifolia (Cuban jute)
- Jacaranda mimosifolia (jacaranda)
- Morinda citrifolia (noni)
- Nephrolepis multiflora (hairy sword fern)
- Lophospermum erubescens (larger roving sailor)

Managers working in the Preserve will monitor these species both within the Preserve and in outlying areas. If any of these species become a threat to the Preserve, species specific management actions to control these species will be under taken.

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Botanical Survey

of

Kaloko Properties

North Kona
Island of Hawai'i

by

Art Whistler, Ph.D.
Isle Botanica
Honolulu, Hawai'i

Report prepared for

Wilson Okamoto Corporation
Honolulu, Hawai'i

December 2006

INTRODUCTION

The current project site encompasses about 1296 acres located in North Kona on the island of Hawai'i. It is situated north of Kona town, and mauka of Ka'ahumanu Highway and the "Kaloko Light Industrial Subdivision," which includes Costco. It is bordered on the west side by the highway, and extends mauka (eastward) to eventually straddle both sides of Hina Lani Road (Fig. 1). The area comprises lava flows of various ages that are covered mostly with a highly disturbed scrub and grass vegetation. However, a relatively undisturbed dryland forest, one of the most biologically diverse yet most heavily damaged ecosystems in the State, covers one area comprising most of the southeastern portion of the property.

BACKGROUND

The USFWS has long recognized the importance of the dryland forest on the site for its unique assemblage of native plants, and has indicated their desire to a preserve a portion of the property for its botanical value. They noted that the dryland forest located on the site is one of the last dryland forests still relatively free of introduced, alien grasses and cattle. The area has remained in such good condition because the substrate is a young lava flow that has acted as a deterrent to cattle, fire, and the spread of alien grasses (USFWS pers. comm. 2006). This patch of forest contains, or has contained, several federally listed endangered plant species: *'aiea* (*Nothocestrum breviflorum*), *ma'oloa* (*Neraudia ovata*), *Cyperus fauriei*, and *hala pepe* (*Pleomele hawaiiensis*). These species are also listed by the State as endangered species (DLNR 1998).

At least two botanical surveys in or adjacent to the area have been conducted. The first was carried out in conjunction with a proposed transmission line that would have crossed the property (CH2M Hill 1993). The second survey was done for the Kaloko town center (site of the present business district that includes Costco), which is adjacent to the current study site (Char and Associates 1995). The CH2M Hill botanical survey crossed the present study area, but also extended in either direction several miles, so the two areas are not exactly comparable. It listed the presence of 101 plant species in that corridor. Three of the species recorded are federally listed endangered species. Five individuals of the sedge *Cyperus fauriei* (known at that time as *Mariscus fauriei*) were noted growing on a single boulder at about 115 m elevation on the 'a'a flow. Two trees of *Nothocestrum breviflorum* were noted growing on the 'a'a flow at 110 m elevation. Two mature individuals of *Neraudia ovata* were noted growing on the 'a'a lava flow at 115 m elevation. The checklist for the Char and Associates botanical survey on the property adjacent to the present study site listed a total of 47 species present, but none of these are federally listed.

In 2003, the USFWS sent a team over for a reconnaissance of the site (USFWS 2003a & b). They noted finding one live specimen of *Neraudia ovata* in the study area, and reported making "a sweep of the area looking for the other four known plants but found none of them. We suspect they may be dead." They also noted the presence of good-sized individuals of *Bidens micrantha* spp. *ctenophylla* (*ko'oko'olau*) in low numbers and one dying *Pleomele hawaiiensis* (*hala pepe*) as well as several other native plant species.

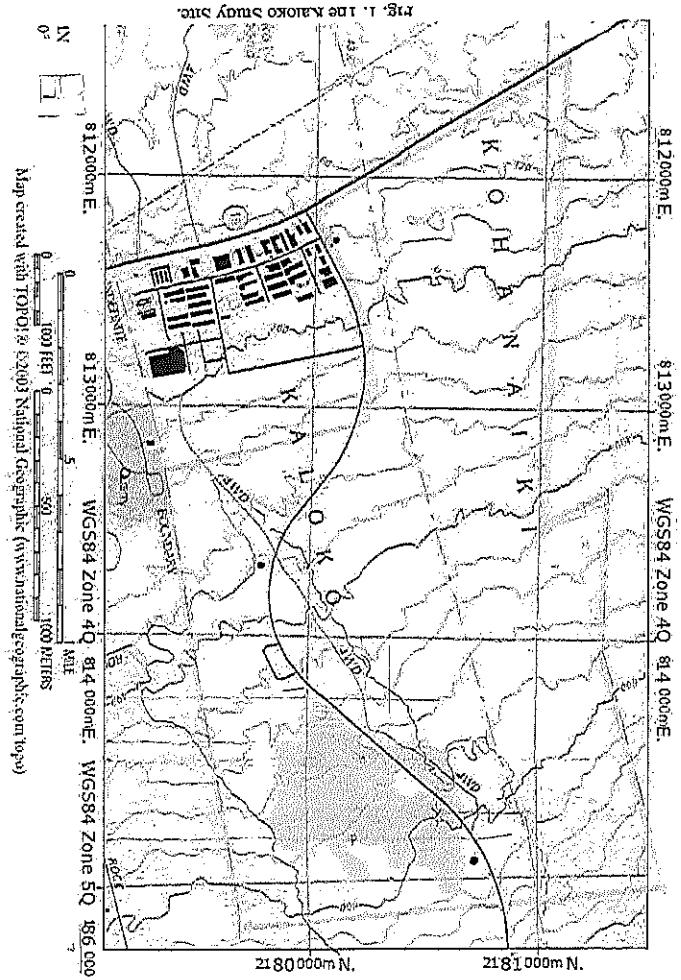

Fig. 1. The Kaloko Study Site.

METHODOLOGY

Before the fieldwork was carried out, a review of the literature was undertaken by the Principal Investigator (PI). The current status of the endangered species previously reported from the site was checked using the official database of threatened and endangered species (USFWS 2005). This list is identical to the State of Hawai'i list of threatened and endangered plant species. In addition, information about threatened and endangered plant species found in the area was extracted from the Hawai'i Natural Heritage Program database (Anon. 2005) of Federally listed plant species (Fig. 2).

After the review of the existing literature, a botanical field survey at the Kaloko site was conducted by a two-person botanical team consisting of the PI (Art Whistler) and a Field Assistant (Beate Neher), from 1 to 6 September 2006. All plant species encountered during the survey were recorded, along with an indication of their frequency. Particular care was taken in the area of dryland forest and other 'a'a areas, since this is where most of the native species and all of the endangered species have been reported. New lists were made for each vegetation type and/or day, and these were combined into a comprehensive checklist of all plants found at the study site (see Appendix). Notes were also taken on vegetation types present at the site, indicating the dominance and frequency of the plant species present. This was later analyzed and written up to form the vegetation section below.

Most of the species encountered during the fieldwork were familiar to the field team. Only one plant observed during the survey defied attempts at identification in the field. It was taken back to Honolulu to the Bishop Museum to compare with specimens there, and was eventually identified with the help of the Bishop Museum Herbarium staff.

THE VEGETATION

Four types of vegetation can be recognized on the Kaloko property: (1) Managed Land Vegetation; (2) Leucaena Scrub, which can be divided into a lowland subtype with extensive amounts of *Pennisetum setaceum* between the trees, and an upland subtype with *Kalanchoë pinnatum* and *Panicum maximum* dominating the ground cover; (3) Christmas-Berry Scrub that occurs on recent 'a'a flows, and which can be divided into two subtypes, one with only scattered Christmas berry trees and a few native species, the other with a similar, denser, scrub forest; and (4) Dryland Forest.

(1) Managed Land Vegetation

This comprises the areas of the parcel that are under periodic or frequent management, such as the edges of roads. It also includes the large quarry on the south side of the dryland forest. This is a relatively minor component of the overall vegetation on the property, and is entirely dominated by alien weedy species, such as the grasses *Digitaria ciliaris* (large crabgrass) and *Rhynchelytrum repens* (Natal redtop), and the dicot herbs *Tridax procumbens* (coat buttons), *Chamaesyce hirta* (garden spurge), *Chamaesyce hyssopifolia*, *Desmodium tortuosum* (Florida beggarweed), *Macroptilium lathyroides* (cow pea), *Boerhavia coccinea*, *Waltheria indica* (*'uhaloa*, a native species), and *Sida rhombifolia* (Cuba jute).

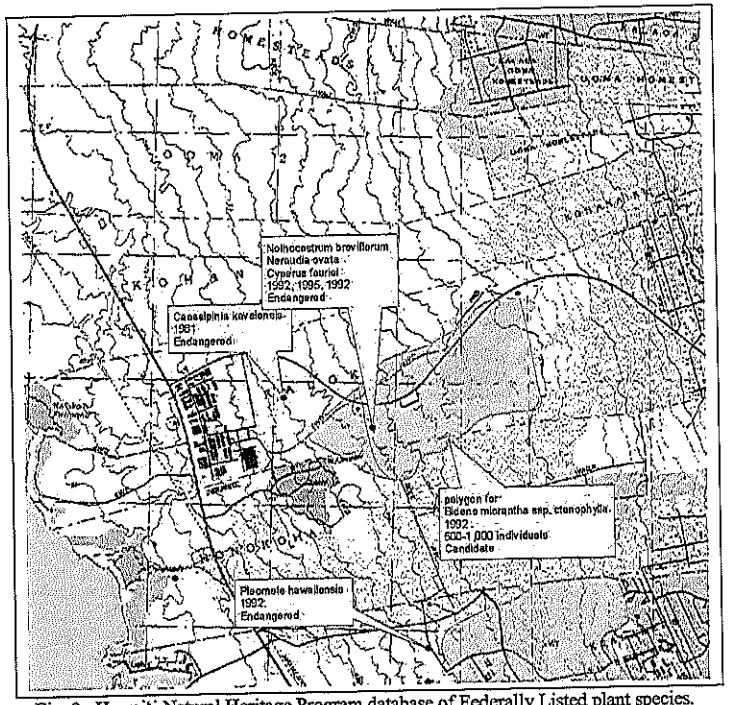

Fig. 3. Hawai'i Natural Heritage Program database of Federally Listed plant species.

(2) *Leucaena* Scrub

This is the type of vegetation found on areas of older lavas dominated by the alien scrubby tree *Leucaena leucocephala* (*koa haole*). It is not a homogeneous type of vegetation, since with increasing elevation along the north side of the road, its density and the species associated with it change. On the lower portions (Fig. 3), *koa haole* is mostly 1–2 m in height, scattered in an open-to-dense matrix of *Pennnisetum setaceum* (fountain grass). Several other trees and shrubs are found here, but in low numbers. This includes the alien tree species *Prosopis pallida* (*kiawe*) and *Schinus terebinthifolius* (Christmas berry), the alien shrub *Acacia farnesiana* (klu), the Polynesian introduction *Morinda citrifolia* (*noni*), and the native shrubs *Dodonaea viscosa* (*'a'ali'i*), *Psydrax odorata* (*'alahe'e*), and *Sida fallax* (*'ilima*). Also present are plants such as the shrubs *Indigofera suffruticosa* (indigo) and *Waltheria indica* (*'uhaloa*), the herbs *Chamaecrista nictitans* (*lau-ki*), *Talinum triangulare* (talinum), and *Portulaca pilosa* (*'ihi*), and

the grasses *Rhynchelytrum repens* (Natal redtop) and *Heteropogon contortus* (*pili*). This might be better described as a mosaic vegetation, with patches of *koa haole* alternating with areas entirely dominated by the fountain grass, but this grass is also found in the partial shade of the *koa haole*, especially when its canopy is thin. It might equally validly be labeled as a fountain grass grassland with associated *koa haole* trees.

At the upper (eastern or mauka) end of the property, the *koa haole* is also dominant, but is denser and taller (2–4 m in height). Instead of forming a mosaic with fountain grass beneath, it forms a dense monodominant scrub forest (Fig. 4). Other tree species are interspersed with it, particularly the native trees or shrubs *Psydrax odorata* (*'alahe'e*), *Diospyros sandwicensis* (*lama*), and *Sophora chrysophylla* (*mamane*), and the alien trees *Schinus terebinthifolius* (Christmas berry) and *Grevillea robusta* (silk oak). The latter two are large and scattered, but appear to be invasive and spreading. The ground cover in this upper area is dominated by *Kalanchoë pinnatum* (air plant) and *Panicum maximum* (Guinea grass), with some *Pennisetum setaceum* (fountain grass) in patches (Fig. 5). The native herb *Peperomia leptostachya* (*'ala'ala-wai-nui*) is occasional on rocks. In disturbed areas across the road from this, next to the upper water tank, the *Leucaena* scrub has an understory of fountain grass (Fig. 6). This differs from the lowland type of *Leucaena* scrub in that the trees are taller and more densely arranged.

Leucaena scrub is classified as disturbed, since fires periodically sweep through the area and goats are known to be present. These two factors account for the dominance of alien species, which are better adapted to these disruptive conditions than are the native species. According to the flora of Hawai'i (Wagner et al. 1999), fountain grass " is rapidly expanding its range in the Kona district of Hawaii." Introduced into the Kona District "in the early 1900s as an ornamental, [it] has aggressively spread and now dominates abandoned pastures, young lava flows, and burn areas. Fountain grass poses one of the most serious contemporary conservation problems because it is disrupting the more sparsely vegetated lowland native dry forests and shrublands, which contain several endangered and many candidate endangered plant species."

(3) Christmas-Berry Scrub

This is the type of vegetation on more recent lava flows, ones that are distinctly 'a'a lava. An irregular tongue of this runs down the slope near the northern boundary of the study site. In the lower portion of the study site, this vegetation is very sparse on the inhospitable surface, but scattered trees of the alien *Schinus terebinthifolius* (Christmas berry) comprise the most common species (Fig. 7). Also found here are scattered individuals of the native trees or shrubs *Capparis sandwichiana* (*pua pilo*), *Psydrax odoratum* (*'alahe'e*), *Metrosideros polymorpha* (*'ohi'a lehua*), *Myoporum sandwicense* (*naio*), as well as the introduced trees *Leucaena leucocephala* (*koa haole*) and *Morinda citrifolia* (*noni*).

The ground cover is also very sparse, with scattered clumps of *Pennisetum setaceum* (fountain grass) found mostly in pockets of soil or pahoehoe, and perhaps being the most common species found here. There were also a few patches of *Ipomoea indica* (*kowali-'awa*) and *Cocculus trilobus* (*huehue*), and even smaller amounts of the alien species *Nephrolepis multiflora* (hairy swordfern), *Lantana camara* (lantana), and *Pluchea carolinensis* (pluchea). Because the vegetation is so sparse, it hardly qualifies as vegetation at all, just scattered trees with equally scattered clumps of herbaceous species.

At higher elevations in this habitat on the same flow, where increasing rainfall and/or cloud cover makes the habitat more hospitable to trees, the vegetation comprises a low closed forest

(Fig. 8) dominated by Christmas berry, with lesser amounts of the native trees *Psydrax odorata* (*'alahe'e*), *Sophora chrysophylla* (*mamane*), and *Diospyros sandwicensis* (*lama*). Tall individuals of *Grevillea robusta* (silk oak) are scattered in the area. The native shrub *Dodonaea viscosa* (*'a'ali'i*) is sometimes common in clearings on the lava. No individuals of *Metrosideros polymorpha* (*'ohi'a lehua*), *Reynoldsia sandwicense* (*'ohe*), *Pleomele hawaiiensis* (*hala pepe*), or *Myoporum sandwicensis* (*naio*) were found in this scrub forest. Because of the dense shade, very little ground cover is present, but that which is present comprises mostly *Panicum maximum* (Guinea grass) and *Kalanchoë pinnatum* (air plant). However, some fountain grass is found in clumps on the lava flow there.

Like the *Leucaena* scrub, this vegetation is classified as disturbed, since fires periodically sweep through the area, and goats are known to be in the area. It somewhat matches the description of the "Lowland Dry Shrublands" described in Wagner et al. (1999), which is described as occurring in leeward situations on most of the main islands, at 100 to 600 m elevation, and being open and not exceeding 3 m in height.

(4) Dryland Forest

This is the open to closed native forest (Figs. 9 and 10) occurring on the relatively recent lava flow comprising most of the central portion of the southern half of the study area. Because of the rugged 'a'a lava, the vegetation is difficult for feral grazing animals to visit. Over much of the area the trees are separated from each other, and this, combined with the virtual absence of fountain grass, has caused the area to be spared from grazing and wildfires. Consequently, the forest is relatively intact, and was home until recently, at least, to four endangered species: *Nothocestrum breviflorum*, *Neraudia ovata*, *Cyperus fauriei*, and *Pleomele hawaiiensis*.

The most common trees are probably the native species *Diospyros sandwicensis* (*lama*), *Psydrax odoratum* (*'alahe'e*), *Capparis sandwichiana* (*pua pilo*; often more of a shrub than a tree), and *Sophora chrysophylla* (*mamane*). Also occasional are the native trees *Metrosideros polymorpha* (*'ohi'a lehua*), *Reynoldsia sandwicensis* (*'ohe*), *Myoporum sandwicensis* (*naio*), and *Dodonaea viscosa* (*'a'ali'i*), as well as scattered individuals of the endangered tree-like monocot *Pleomele hawaiiensis* (*hala pepe*). The only alien tree species noted in this open forest were *Jacaranda mimosifolia* (jacaranda), the Polynesian introduction *Morinda citrifolia* (*noni*), *Schinus terebinthifolius* (Christmas berry), and *Leucaena leucocephala* (*koa haole*). The latter two species, especially Christmas berry, sometimes form clumps and in some places dominate the edges of the dryland forest. The southern boundary of this forest has recently been bulldozed in quarry activities, and fountain grass is spreading in this newly created disturbed habitat (Fig. 11).

The ground cover in the dryland forest is very sparse, due to the inhospitable growing conditions. The most common species in this category are *Lantana camara* (lantana), the native vines *Cocculus trilobus* (*huehue*) and *Ipomoea indica* (*kowali-'awa*), *Pennisetum setaceum* (fountain grass), *Nephrolepis multiflorum* (hairy swordfern), and an escaped ornamental vine *Lophospermum erubescens* (larger roving sailor).

Overall, this vegetation comprises a good quality dryland forest, based upon the flora and the dominance of native species. The native flora is virtually the same as that found in the list of the native flora on the whole site shown in Table 1 (below), with the possible exception of *Heteropogon contortus* (*pili*), which was found elsewhere on the study site but not in the dryland forest.

THE FLORA

A total of 93 plant species (see Appendix) was recorded in the study area, but this does not include a few cultivated species planted along the roadsides. Twenty-five of the species encountered are native and eleven of these native species are endemic. Indigenous plants are species that are native to a region or place, but are also found elsewhere. Endemic plants are species restricted to a single region or area, i.e., in the case of Hawai'i, they are found only in Hawai'i. In biodiversity terms, the endemic status is the more important of the two categories, since if a species belonging to it is endangered or threatened in Hawai'i, it would likewise be classified globally. Indigenous species, however, can be classified as threatened or endangered in Hawai'i, but may be common elsewhere in the Pacific. Over 90% of the native plants in Hawai'i are endemic, one of the highest rates in the world.

The majority of the 93 species encountered during the survey are naturalized "alien" plants that were accidentally or intentionally introduced to Hawai'i, but which have now become established in the islands and can spread on their own. The checklist of Char and Associates (1995) included several other species found on the adjacent property that were not found during the present survey: *Bidens cynapiifolia* (beggar's tick), *Cucumis dipsaceus* (wild cucumber), *Tephrosia purpurea* (*'auhuhu*), *Abutilon incanum* (hoary abutilon), *Boerhavia repens* (*alena*), and *Solanum americanum* (*popolo*). All of these except *Tephrosia purpurea* are herbaceous species that die back during the dry season, and consequently would likely turn up in the current study area during a survey in the rainy season. Three of them are native (or questionably so), but none are endemic.

Only one of the native species found during the present survey, *Pleomele hawaiiensis*, is a federally listed endangered species. Hawai'i Natural Heritage Program database map (Fig. 2) shows a record of *Caesalpinia kavaiensis* (*uhiuhi*) as occurring between the current study site and the industrial area, but the date on this record is 1981 and the tree has probably died by now, since it has not been recorded there since that time. (Also, it is located outside of the present study site.) A list of native species found at the study site is shown in Table 1. The other three endangered plant species, *Cyperus fauriei*, *Nothocestrum breviflorum*, and *Neraudia ovata*, previously reported from the dryland forest were not encountered during the present survey, and may have disappeared from the site.

DISCUSSION

Only one of the species encountered during the survey is Federally Listed as Threatened or endangered, *Pleomele hawaiiensis* (Fig. 12). According to the USFWS, "six to eight populations are currently known: one to three in the Puu Waawaa region of Hualalai on State-leased and private land, two in the Kaloko/Kaloao area on private land, two in the Kapua/Kahuku area on private land, and one on Holei Pali within Hawaii Volcanoes National Park. These populations total 250–300 individuals, of which over 75 are found at Kaloko. Kaloko represents one of only

Table 1. Native species found at the study site

Argemone glauca (Papaveraceae)	pua kala	Endemic
Bidens micrantha		

subsp. *ctenophylla* (Asteraceae)	ko'oko'olau	Endemic
Capparis sandwichiana (Capparaceae)	pua pilo	Endemic
Chamaesyce celastroides (Euphorbiaceae)	'atoto	Endemic
Cocculus trilobus (Menispermaceae)	huehue	Indigenous
Diospyros sandwicensis (Ebenaceae)	lama	Endemic
Dodonaea viscosa (Sapindaceae)	'a'ali'i	Indigenous
Doryopteris decipiens (Adiantiaceae)	kumuniu	Endemic
Heteropogon contortus (Poaceae)	pili grass	Indigenous?
Ipomoea indica (Convolvulaceae)	koali-'awa	Indigenous
Lipochaeta subcordata (Asteraceae)	———	Endemic
Metrosideros polymorpha (Myrtaceae)	'ohi'a lehua	Endemic
Myoporum sandwicense (Myoporaceae)	naio	Indigenous
Osteomeles anthyllidifolia (Rosaceae)	'ulei	Indigenous
Peperomia leptostachya (Piperaceae)	'ala'ala-wai-nui	Indigenous
Plectranthus parviflorus (Lamiaceae)	spurflower	Indigenous
Pleomele hawaiiensis (Agavaceae)	halapepe	Endemic
Psilotum nudum (Psilotaceae)	moa	Indigenous
Psydrax odoratum (Rubiaceae)	alahe'e	Indigenous
Reynoldsia sandwicensis (Araliaceae)	'ohe	Endemic
Scaevola sericea (Goodeniaceae)	naupaka	Indigenous
Senna gaudichaudii (Fabaceae)	kolomona	Indigenous
Sida fallax (Malvaceae)	'ilima	Indigenous
Sophora chrysophylla (Fabaceae)	mamane	Endemic
Waltheria indica (Sterculiaceae)	'uhaloa	Indigenous

two known populations that are successfully regenerating" (USFWS 2006, pers. comm.). During the present survey, only about 24 plants were observed, but since counting individuals was not part of the project, this should not be judged to be indicative of a decline in the number of individuals currently there. The species is not included on the Hawai'i Natural Heritage Program Database map (Fig. 2).

Several other endangered species have been reported from the dryland forest area, but were not found during the present survey. According to the USFWS, the endangered *Nothocestrum brevifolium* is "historically known from 15 locations extending from the southern Kohala Mountains, south along the leeward side of the Big Island, to the South Point area. Currently, six populations are known. Two of the 53 known individuals of this species occur in Kaloko (USFWS pers. comm. 2006)." The Hawai'i Natural Heritage Program Database (Fig. 2) noted a location of the plant in the dryland forest and dates this record to 1992. Rex Palmer observed the plant growing in the dryland forest only three years ago (pers. comm. 2006). The Division of Forestry and Wildlife (DOFAW) representative Lyman Perry (pers. comm. 2006) noted his belief that "...*Nothocestrum* [has] not been observed in this area for quite some time...The nearest *Nothocestrum* locations that I know of are in Kaupulehu (above the road at the 28 mile marker in the NTBG 6 acre enclosure)." A site visit by USFWS personnel in 2003 looking at endangered species did not report finding it either (USFWS 2003 a&b).

A third endangered species, *Neraudia ovata*, has been reported from the dryland forest. Palmer (pers. comm. 2006) noted its presence there in 2003 growing under trees near to where homeless people are known to camp. The presence of a single flowering and fruiting plant was reported there in 2003 (USFWS 200 3a&b). Lyman Perry (pers. comm. 2006) noted "...*Neraudia* [has] not been observed in this area for quite some time...The nearest known location of *Neraudia* was the lava flow behind COSTCO on Hina Lani Street but those plants died in the last couple of years." The Hawai'i Natural Heritage Program Database (Fig. 2) shows its occurrence in the area in 1995.

A fourth endangered species has been reported from the dryland forest, the endemic *Cyperus fauriei* (formerly known as *Mariscus fauriei*). According to the USFWS, "only four populations are currently known: 20–30 plants on State owned land on Molokai, 22 plants in two populations on State owned land on the southern end of the island of Hawaii, and five plants in Kaloko, on private land" (USFWS pers. comm. 2006). This information about its presence at Kaloko is probably based on the record from the survey described in CH2M Hill (1993). The Hawai'i Natural Heritage Program Database (Fig. 2) shows its presence there in 1992, apparently also based on the CH2M Hill report.

The Hawai'i Natural Heritage Program Database map (Fig. 2) also shows a record of the federally listed endangered tree *Caesalpinia kavaiensis* (*uhiuhi*) as occurring in the area just west of the study site and east of the industrial area, but it apparently has not been seen for years and was not noted in the USFWS 2003 site visit report (USFWS 2003a&b).

CONCLUSIONS AND RECOMMENDATIONS

Based upon the survey, there are three main kinds of vegetation at the site: (1) disturbed scrub dominated by *Leucaena leucocephala* (*koa haole*) in combination with *Pennisetum setaceum* (fountain grass) in the lower part of the study site, and with *Kalanchoē pinnatum* (air plant) and *Panicum maximum* (Guinea grass) in the upper part; (2) disturbed scrub dominated by *Schinus terebinthifolius* (Christmas berry); and (3) relatively undisturbed dryland forest. The two kinds of disturbed vegetation occupy most of the site. The USFWS, based on notes from 1996, reported their belief that the dryland forest was approximately 200 acres (80 hectares) in area (USFWS pers. comm. 2006). By this reckoning, the disturbed vegetation comprises about 1100 acres (1296 minus 200) of the site. No Federally listed endangered or threatened plant species were recorded in this disturbed area.

The dryland forest is a different story. It constitutes valuable and irreplaceable habitat for Hawai'i's unique biota, and consequently has major cultural and biological significance. It is one of the last few remaining, relatively undisturbed patches of this dryland forest habitat in Hawai'i. Twenty-five native species were recorded from this site, eleven of them endemic to Hawai'i (i.e., found nowhere else in the world). Four of these (three found during previous surveys only, and one during the present and previous surveys) are federally listed endangered species. Some of these species are very rare since they are restricted to only a few localities. This combination of rare vegetation, rare native species, and federally listed endangered species make this remnant dryland very important to the biodiversity of Hawai'i. The USFWS is bound by law to protect these species and consequently they will need to protect this area of dryland forest where they occur. However, the USFWS has previously noted that they would not hinder any development plans for the areas of disturbed vegetation at the site if the dryland forest were to be set aside and given protection status (USFWS. pers. comm. 2006). Consequently, the

owners will have to negotiate with the USFWS and DOFAW on just how much land needs to be set aside for this protection. They may also have to overcome local opposition to the project, so they should make it clear that they are also interested in preserving these unique and rare species, within the confines of development for the major portion of the parcel.

It is also recommended that of some of the rare and endemic species occurring on the site or in the general area should be considered for any landscaping that will be done, such as around utility buildings and public structures. This would be a win-win situation. Some of the species make attractive ornamentals, and are already adapted to the dryland conditions at the site. Thus they require little maintenance and watering. Using rare or culturally significant species would also help to alleviate any local or governmental concerns that the project would be detrimental to the survival of these rare species. Some of these species are already being propagated by local gardeners and gardens, such as the nearby Amy Greenwell Garden. These may be available for purchase, or these individuals or gardens could be hired to do the local plant landscaping. Some species recommended for this are as follows:

Aleurites moluccana (*kukui*)—This species is a Polynesian introduction to Hawai'i rather than a native species, but it has important cultural significant since it seeds were traditionally used for night time illumination (hence its English name candlenut. Currently the seeds are used to produce massage oil and the fruits are fashioned into attractive, jet-black seed leis. It gray-green leaves and large stature make it a popular ornamental tree in Hawai'i.

Bidens micrantha subsp. *ctenophylla* (*ko'oko'olau*)—An endemic shrub that was formerly a candidate, federally listed endemic species. It is restricted mostly to this part of the island of Hawai'i and has small, attractive, yellow, sunflower-like flowers (Fig. 13)

Capparis sandwichiana (*pua pilo, pua pilo*)—An endemic shrub or small tree with large, attractive white, fragrant flowers. It relatively rare in Hawai'i, but does well on lowland lava flows.

Erythrina sandwicensis (*wiliwili*)—A spreading endemic tree with showy seasonal red flowers, found in the area, but not recorded from the study site. It is a popular, long-lived, native ornamental tree in Hawai'i that is related to the ornamental coral tree (*Erythrina variegata*).

Metrosideros polymorpha (*'ohi'a lehua*)—This is the indigenous, medium-sized tree covering much of the island, and has attractive red, powderpuff-like flowers. Some varieties also have attractive gray-green leaves. It is uncommon at the site, probably because the area does not get enough rainfall to allow it to flourish, but it dominates the intact forests upslope.

Myoporum sandwicense (*naio*)—An indigenous small tree or shrub with small, fragrant white flowers. Its English name is false sandalwood, indicative of its fragrant wood once used like sandalwood. The plant is easily grown from cuttings.

Osteomeles anthyllidifolia (*'ulei*)—A sprawling indigenous shrub that makes a nice shrubby ground cover. It has attractive but small, white, rose-like flowers (it is a member of the rose family).

Pleomele hawaiiensis (*halapepe*)—A federally listed endangered endemic species. This yucca-like plant is similar to the money tree (*Dracaena marginata*) that is a popular ornamental plant in Hawai'i.

Psydrax odoratum (*alahe'e*)—A small indigenous tree or shrub fairly common at the site, to which it is well adapted. It has attractive dark green leaves, thick canopy, and baseball-sized clusters of fragrant, attractive white flowers.

Reynoldsia sandwicensis (*'ohe*)—A large, fast growing endemic tree with an open canopy.

Senna gaudichaudii (*kolomona*)—Small indigenous tree with pale yellow flowers. It is similar to the scrambled eggs tree (*Senna surattensis*) that is a popular ornamental tree in Hawai'i, and which is also naturalized at the site.

Sida fallax (*'ilima*)—An indigenous shrub common at the site. It is a popular ornamental in Hawai'i, where the orange mallow-like flowers are fashioned into exquisite leis.

Sophora chrysophylla (*mamane*)—An endemic small tree or shrub common on the Big Island, especially at higher elevations. It has attractive yellow, sweetpea-like flowers and an unusual, bead-necklace-like pod.

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TABLE 1. PLANT SPECIES CHECKLIST FOR THE KALOKO PROPERTY

The following is a checklist of the vascular plants inventoried during the field studies on the Kaloko planned development area. The plants are divided into three groups, Ferns (including fern allies), Monocots, and Dicots. Within these groups, the species are presented taxonomically by family, with each family and each species in the family in alphabetical order. The taxonomy and nomenclature of the ferns follow Palmer 2003 and the flowering plants (Monocots and Dicots) follow Wagner *et al.* (1999). In most cases, common English and/or Hawaiian names listed here have been taken from St. John (1973) or Porter (1972). Native plants are shown in **bold.**

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name, when known.
3. Biogeographic status. The following symbols are used.
   E = endemic (found only in Hawai'i).
   I = indigenous (native to Hawai'i as well as other geographic areas).
   P = Polynesian introduction (introduced to Hawai'i by Polynesians before the advent of the Europeans).
   X = Introduced or alien (not native, introduced to Hawai'i, either accidentally or intentionally, after the advent of the Europeans).
4. Relative frequency (abundant, locally abundant, common, locally common, occasional, uncommon, rare).

Species	Common Names	Status	Abundance
FERNS AND FERN ALLIES			
ADIANTACEAE (Maiden's-hair Family)			
Doryopteris decipiens (Hook.) J. Sm.	kumuniu	E	
NEPHROLEPIDACEAE (Sword Fern Family)			
Nephrolepis multiflora (Roxb.) Jarret ex Morton	hairy swordfern	X	
PSILOTACEAE (Psilotum Family)			
Psilotum nudum L.	moa	I	
POLYPODIACEAE (Common Fern Family)			
Phymatosorus grossus (Langsd. & Fisch.) Brownlie	laua'e	X	
MONOCOTS			
AGAVACEAE (Agave Family)			
Pleomele hawaiiensis Degener and I. Degener	halapepe	E	

Species	Common Names	Status
COMMELINACEAE (Spiderwort Family)		
Commelina benghalensis L.	hairy honohono	X
DIOSCOREACEAE (Yam Family)		
Dioscorea bulbifera L.	bitter yam, hoi	P
POACEAE (Grass Family)		
Cenchrus echinatus L.	sandbur	X
Chloris barbata (L.) Sw.	swollen fingergrass	X
Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	X
Digitaria ciliaris (Retz.) Koeler	large crabgrass	X
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	love grass	X
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	pili grass	I
Melinus minutiflora P. Beauv.	molasses grass	X
Panicum maximum Jacq.	Guinea grass	X
Pennisetum setaceum (Forssk.) Chiov.	fountain grass	X
Rhynchelytrum repens (Willd.) C.E. Hubb.	Natal redtop	X
DICOTS		
AMARANTHACEAE (Amaranth Family)		
Amaranthus viridis L.	slender amaranth	X
ANACARDIACEAE (Mango Family)		
Schinus terebinthifolius Raddi	Christmas berry	X
APOCYNACEAE (Periwinkle Family)		
Catharanthus roseus (L.) G. Don	Madagascar periwinkle	X
ARALIACEAE (Panax Family)		
Reynoldsia sandwicensis A. Gray	'ohe	E
ASTERACEAE (Sunflower Family)		
Ageratum conyzoides L.	ageratum	X
Bidens micrantha Gaud. subsp. *ctenophylla* (Sherff) Nagatga & Ganders	———	E
Emilia fosbergii Nicolson	red pualele, emilia	X
Emilia sonchifolia (L.) DC.	pualele, emilia	X
Lipochaeta subcordata A. Gray	———	E
Pluchea carolinensis (Jacq.) G. Don	pluchea	X
Senecio madagascariensis Poir.	fireweed	X
Tridax procumbens L.	coat buttons	X
BIGNONIACEAE (Bignonia Family)		
Jacaranda mimosifolia D. Don	jacaranda	X
Spathodea campanulata P. Beauv.	African tulip tree	X
BUDDLEIACEAE (Butterfly-bush Family)		
Buddleia asiatica Lour.	dogtail, heulo'ilio	X

Species	Common Names	Status

Species	Common Names	Status
CACTACEAE (Cactus Family)		
Hylocereus undatus (Haw.) Britten & Rose	night-blooming cereus	X
Opuntia ficus-indica (L.) Mill.	prickly pear, panini	X
CAPPARACEAE (Caper Family)		
Capparis sandwichiana DC	pua pilo	E
CLUSIACEAE (Mangosteen Family)		
Clusia rosea Jacq.	autograph tree	X
CONVOLVULACEAE (Morning-Glory Family)		
Ipomoea indica (J. Burm.) Merr.	koali-'awa	I
Ipomoea obscura (L.) Ker-Gawl.	bindweed	X
CRASSULACEAE (Stonecrop Family)		
Kalanchoë pinnata (Lam.) Pers.	air plant	X
CUCURBITACEAE (Gourd Family)		
Coccinea grandis (L.) Voigt	ivy gourd	X
Momordica charantia L.	wild bittermelon	X
EBENACEAE (Ebony Family)		
Diospyros sandwicensis (A. DC.) Fosb.	lama	E
EUPHORBIACEAE (Spurge Family)		
Aleurites moluccana (L.) Willd.	candlenut, kukui	P
Chamaesyce celastroides (Boiss.) Croziat and Degener	'atoto	E
Chamaesyce hirta (L.) Millsp.	garden spurge	X
Chamaesyce hyssopifolia (L.) Small	———	X
Macaranga tanarius (L.) Muell. Arg.	———	X
Ricinus communis L.	castor bean	X
FABACEAE (Pea Family)		
Acacia farnesiana (L.) Willd.	klu	X
Chamaecrista nictitans (L.) Moench	partridge pea, lau-ki	X
Crotalaria pallida Aiton	smooth rattlepod	X
Desmodium incanum DC.	Spanish clover	X
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X
Indigofera suffruticosa Mill.	indigo, 'iniko	X
Leucaena leucocephala (Lam.) de Wit	koa haole	X
Macroptilium lathyroides (L.) Urb.	cow pea	X
Pithecellobium dulce (Roxb.) Benth.	'opiuma, Manila tamarind	X
Prosopis pallida (Humb. & Bonpl.ex Willd.) Kunth	kiawe, mesquite	X
Senna occidentalis (L.) Link	coffee senna	X
Senna gaudichaudii (Hook. & Arn.) H. Irwin & Barneby	kolomona	I

Species	Common Names	Status
FABACEAE (cont'd.)		
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona	X
Sophora chrysophylla (Salisb.) Seem.	mamane	E
GOODENIACEAE (Goodenia Family)		
Scaevola sericea Vahl	naupaka	I
LAMIACEAE (Mint Family)		
Hyptis pectinata (L.) Poir.	comb hyptis	X
Plectranthus parviflorus Willd.	spurflower	I
MALVACEAE (Mallow Family)		
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X
Malvastrum coromandelianum (L.) Garcke	false mallow	X
Sida fallax Walp.	'ilima	I
Sida rhombifolia	Cuba jute	X
MENISPERMACEAE (Moonseed Family)		
Cocculus trilobus (Thumb.) DC.	huehue	I
MYOPORACEAE (False-sandalwood Family)		
Myoporum sandwicense A. Gray	naio, false sandalwood	I
MYRTACEAE (Myrtle Family)		
Metrosideros polymorpha Gaud.	'ohi'a lehua	E
Psidium guajava L.	guava	X
NYCTAGINACEAE (Four-o'-Clock Family)		
Boerhavia coccinea Mill.	———	X
PAPAVERACEAE (Poppy Family)		
Argemone glauca (Nutt. ex Prain) Pope	pua kala	E
PASSIFLORACEAE (Passionflower Family)		
Passiflora edulis Sims	passionfruit, liliko'i	X
Passiflora foetida L.	love-in-a-mist	X
PHYTOLACCACEAE (Pokeweed Family)		
Rivina humilis L.	rouge plant	X
PIPERACAEAE (Pepper Family)		
Peperomia leptostachya Hooker & Arnott	'ala'ala-wai-nui	I
PORTULACACEAE (Purslane Family)		
Portulaca oleracea L.	common purslane	X
Portulaca pilosa L.	'ihi	X
Talinum triangulare (Jacq.) Willd.	talinum	X
PROTACEAE (Protea Family)		
Grevillea robusta A. Cunn. ex R. Br.	silk oak	X
ROSACEAE (Rose Family)		
Osteomeles anthyllidifolia (Sm.) Lindl.	'ulei	I

Species	Common Names	Status
RUBIACEAE (Coffee Family)		

Morinda citrifolia L.	Indian mulberry, noni	P
Psydrax odoratum (Forst. f.) A. C. Sm. & S. Darwin	alahe'e	I
SAPINDACEAE (Soapberry Family)		
Dodonaea viscosa Jacq.	'a'ali'i	I
SCROPHULARIACEAE (Snap-dragon Family)		
Lophospermum erubescens D. Don	larger roving sailor	X
SOLANACEAE (Nightshade Family)		
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato	X
STERCULIACEAE (Cacao Family)		
Waltheria indica L.	'uhaloa	I
VERBENACEAE (Verbena Family)		
Lantana camara L.	lantana	X
Stachytarpheta australis Moldenke	owi	X
Stachytarpheta cayennensis (Rich.) Vahl	blue rat's-tail	X

Fig. 3. *Leucaena* scrub at lower end of study site.

Fig. 4. *Leucaena* scrub on the north-central part of the study site.

Fig. 5. *Kalanchoë pinnata* dominating underneath a *Leucaena* canopy at north-central part of the site.

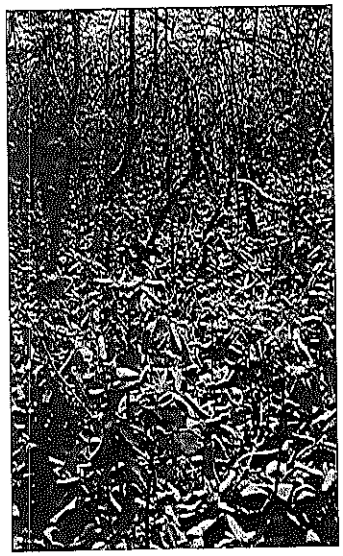
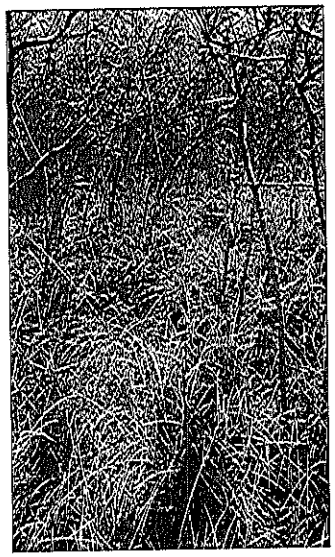


Fig. 6. Fountain grass growing under *Leucaena* trees.



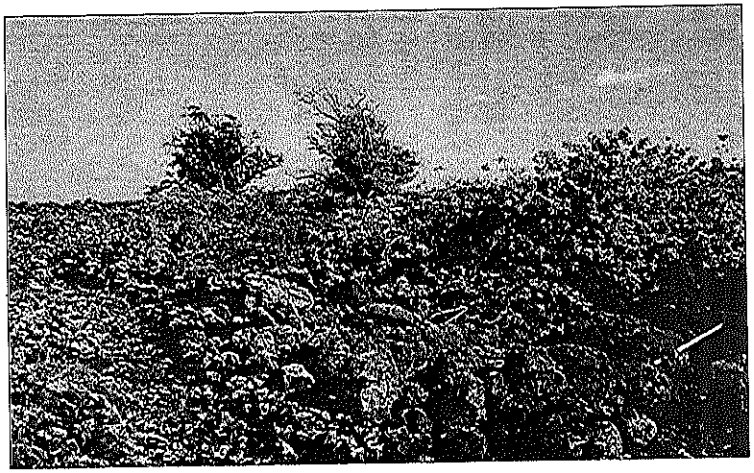


Fig. 7. Sparse Christmas-berry scrub at northeast corner of the study site.

Fig. 8. Upper lava flow dominated by Christmas berry.

Fig. 9. Open lava in the dryland forest

Fig. 10. Dense dryland forest.

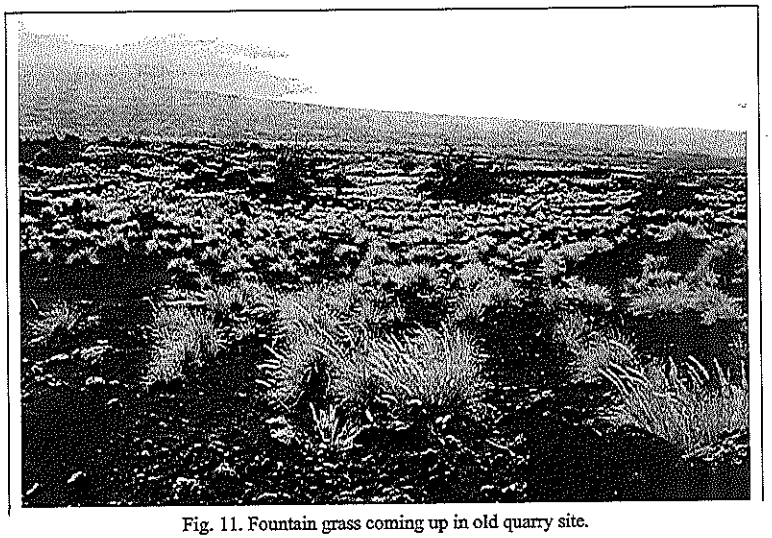


Fig. 11. Fountain grass coming up in old quarry site.

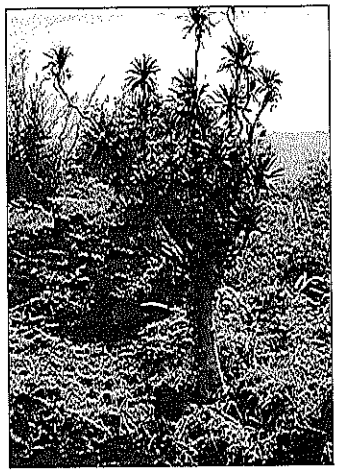


Fig. 12. *Pleomele hawaiiensis.*

Fig. 13. *Bidens micrantha* subsp. *ctenophylla.*

A Survey of Avian and Terrestrial Mammalian Species on TMK (3) 7-3-09:17, 25, 26, and 28, at Kaloko, and Kohanaiki, North Kona District, Island of Hawai'i.

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Introduction

This report summarizes the findings of avian and mammalian surveys conducted on an approximately 1,151-acre parcel of land identified as TMK (3) 7-3-09:17, 25, 26, and 28. The property is located in the Kaloko, and Kohanaiki *Ahupua'as*, in the North Kona District, Hawai'i (Figure 1).

The primary purpose of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either the federal or the State of Hawai'i's endangered species programs on, or within in the immediate vicinity of the site. Federal and State of Hawai'i listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted between September 7 and 11, 2006.

Avian phylogenetic order and nomenclature follows *The American Ornithologists' Union Check-list of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Higher native and naturalized plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 14.

General Site Description

The approximately 1,151-acre parcel of land is located in Kaloko, in the North Kona District. The site is transected by the existing Hina Lani Street, and is located immediately upslope (*mauka*) of the Kaloko Light Industrial Park. The site is bound to the northeast, east and south by undeveloped land. The northwest boundary of the site is along Queen Ka'ahumanu Highway, the southwest corner is bound by the Kaloko Light Industrial Park, and the northwest by the Kohanaiki Industrial Park (Figure 1). The site gently slopes from east to west from a maximum elevation of ~ 740-feet above mean sea level (ASL) at the northeastern boundary, down to ~ 60-feet ASL at the northwestern boundary, located along Queen Ka'ahumanu Highway (USGS 1996). The project area consists to three distinct lava flows, the oldest is an 'a'ā flow disgorged from Mount Hualālai between 5,000 and 10,000 years ago, most of this flow has been covered by a mix of weathered broken pāhoehoe, and 'a'ā flows deposited some 3,000 to 5,000 years ago, much of this flow has since been covered by newer flows laid down between 1,500

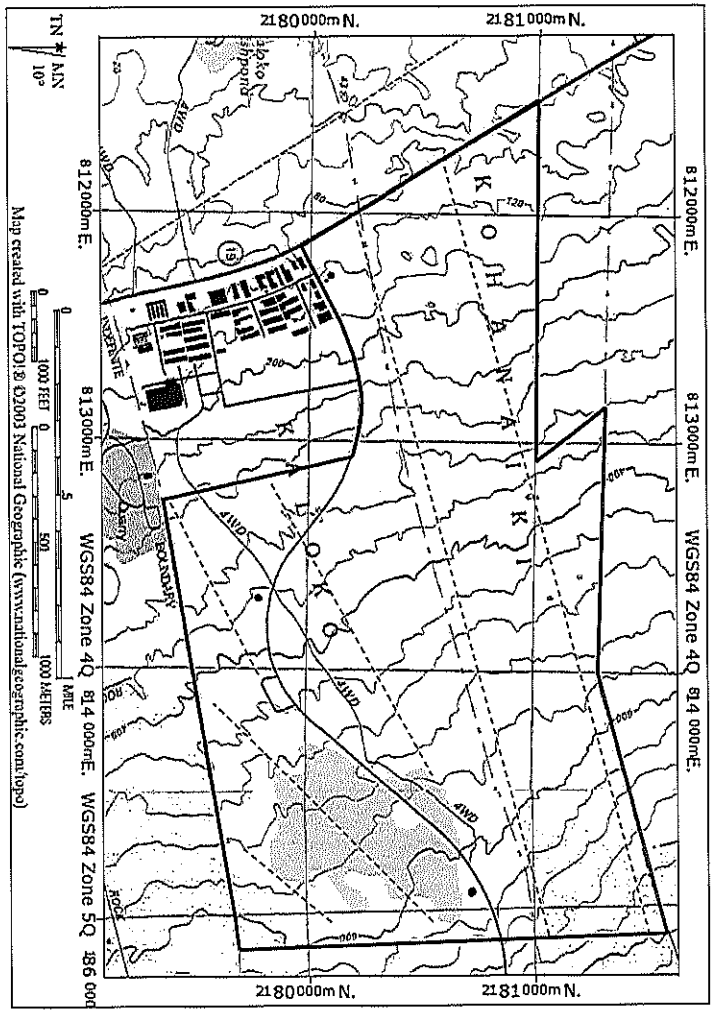
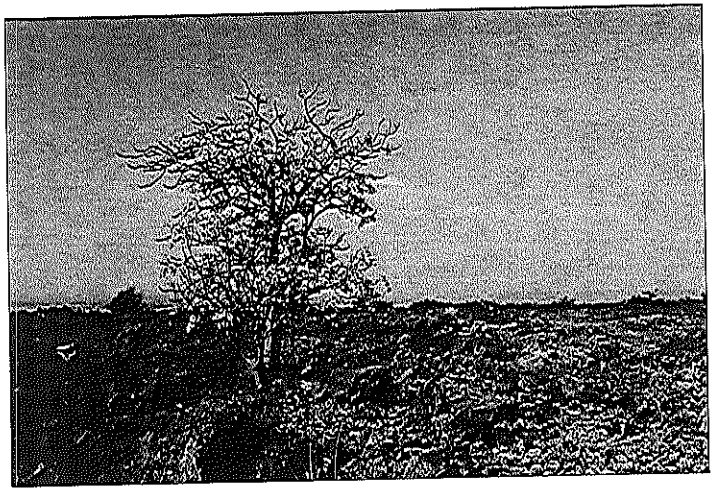


Figure 1 – Kaloko Properties Study Site
Red Line Represents Approximate Boundaries of the Site – Blue Dotted Lines Indicate Avian Transects

and 3,000 years ago (Wolfe and Morris 1996, USGS 1996).

The vegetation present on the oldest 'a'ā flows not covered by newer flows has a high degree of native components remaining, including several rare and endangered species (Figure 2). The bulk of the site, however, is dominated by alien vegetation. This dominant vegetation can be best characterized as a Fountain Grass/ Koa Haole Grassland subtype of a Lowland Dry Grassland Community as described in Gagne and Cuddihy (1990) (Figure 3).

Figure 2
Dryland Forest Vegetation on 'A'ā Flows,
***'ohe makai* (*Reynoldsia sandwicensis*) in the foreground**



Avian Survey Methods

Thirty-two avian count stations were sited at approximately 300-meter intervals along six linear transects running from east-to-west through the project area (Figure 1). One six-minute point count was conducted at each station. Field observations were made using Leitz 10 X 42 binoculars to sight birds and by listening for vocalizations. Counts took place between 06:30 a.m. and 10:30 a.m., the peak of daily bird activity. In an attempt to detect nocturnally flying seabirds over-flying the project area. An additional two hours were spent within the project area on the evenings of September 7th, 8th and 9th on the

mornings of September 8th, 9th, and 10th, 2006. Time not spent counting was used to search the study site for species and habitats that were not detected during count sessions.

Figure 3
Typical Fountain Grass/ Koa Haole Grasslands

Avian Survey Results

A total of 881 individual birds of 20 different species, representing 11 separate families were recorded during station counts. Additionally, one other species, Barn Owl (*Tyto alba*) was recorded as an incidental observation on the evening of September 7, 2006. One of the species recorded, Pacific Golden-Plover (*Pluvialis fulva*) is an indigenous migratory shorebird species that nests in the high Arctic, returning to Hawaii and the Tropical Pacific to spend the fall and winter months each year. The remaining 18 species detected are considered to be alien to the Hawaiian Islands, with one of them, Red Junglefowl (*Gallus gallus*) a domestic species, not currently considered to be established in the wild on the Island of Hawai'i (Table 1).

No avian species currently listed as endangered, threatened, or proposed for listing under either the federal or the State of Hawai'i's endangered species programs were detected during the course of this survey.

Avian diversity and densities were relatively low, though in keeping with the extremely dry habitat present on the site. Three species, House Finch (*Carpodacus mexicanus*), Zebra Dove (*Geopelia striata*), and Japanese White-eye (*Zosterops japonicus*), accounted for 43% of the total number of individual birds recorded. House Finchs were the most frequently recorded species, accounting for slightly more than 17% of the total number of individual birds recorded during station counts. An average of 27 birds were recorded per station count.

Table 1

Avian Species Detected Within the Kaloko Properties Study Site

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.84
Black Francolin	*Francolinus francolinus*	A	0.56
Erckel's Francolin	*Francolinus erckelii*	A	0.06
Red Junglefowl	*Gallus gallus*	D	0.06
Kalij Pheasant	*Lophura leucomelanos*	A	0.09
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.34
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	2.22
Zebra Dove	*Geopelia striata*	A	3.66
	STRIGIFORMES		
	TYTONIDAE - Barn Owls		
Barn Owl	*Tyto alba*	A	I-1
	PASSERIFORMES		
	ZOSTEROPIDAE - White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	3.44
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	A	0.22
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	2.25
	EMBERIZIDAE - Emberizids		
Saffron Finch	*Sicalis flaveola*	A	1.31

Common Name	*Scientific Name*	*ST*	*RA*
Yellow-billed Cardinal	*Paroaria capitata*	A	0.88
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	1.56
	FRINGILLIDAE - Fringilline and Carduleline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	4.75
Yellow-fronted Canary	*Serinus mozambicus*	A	1.31
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	A	0.66
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
African Silverbill	*Lonchura cantans*	A	2.03
Nutmeg Mannikin	*Lonchura punctulata*	A	0.66
Java Sparrow	*Padda oryzivora*	A	1.13

KEY TO TABLE 1

ST Status

A Alien – Introduced to the Hawaiian Islands by humans

D Domestic Species – Not considered to be established in the wild on the Island of Hawai'i

IM Indigenous Migratory Species

RA Relative Abundance – Number of birds detected divided by the number of count stations (32)

I- Incidental – Species detected incidentally, followed by the number of individuals recorded

Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of Hawai'i are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed and heard within the study area. Visual and electronic scans, using a Broadband AnaBat II® ultrasonic bat detector, were made for bats during crepuscular periods on the evening of September 7, 8 and 9, 2006.

Mammalian Survey Results

A total of nine mammalian species were detected while on the site. Seven European house mice (*Mus musculus domesticus*) were seen within the study area (Table 1). A total of five small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations within the study site, as were two cat (*Felis catus*), one pig (*Sus s. scrofa*) and 35+ goats (*Capra h. hircus*). Additionally, skeletal remains were encountered of small

Indian mongoose, cat, pig, cattle (*Bos Taurus*), goat and sheep (*Ovis aries*). Tracks and sign of dogs (*Canis f. familiaris*), was encountered in several locations within the study area.

Hawai'i's sole endemic terrestrial mammalian species, the endangered Hawaiian hoary bat, was not detected during the survey, though I did record one bat as an incidental observation on the evening of September 15, 2006, while driving up Hina Lani Street. All of the alien mammalian species recorded during this survey are deleterious to avian and floristic components of the remaining native ecosystems present on the Island.

Table 2

Mammalian Species Detected Within the Kaloko Properties Study Site

Common name	*Scientific name*	Status
	CHIROPTERA - BATS	
	VESPERTILIONIDAE - Common Bats	
Hawaiian hoary bat	*Lasiurus cinereus semotus*	EE
	RODENTIA - GNAWERS	
	Muridae - Old World Rats & Mice	
European house mouse	*Mus musculus domesticus*	A
	CARNIVORA- FLESH EATERS	
	Canidae - Wolves, Jackals & Allies	
Domestic dog	*Canis f. familiaris*	A
	Viverridae - Civets & Allies	
Small Indian mongoose	*Herpestes a. auropunctatus*	A
	Felidae- Cats	
House cat	*Felis catus*	A
	ATRIODACTYLA - EVEN-TOED UNGULATES	
	Suicidae - Old World Swine	
Pig	*Sus s. scrofa*	A
	Bovidae- Hollow-horned Ruminants	
Domestic cattle	*Bos taurus*	A
Domestic goat	*Capra h. hircus*	A
Domestic sheep	*Ovis aries*	A

KEY TO TABLE 2

A Alien – Introduced to the Hawaiian Islands by humans

EE Endangered Endemic – Native and unique to the Hawaiian Islands

Discussion

Avian Resources

Avian diversity and densities detected during this survey were in keeping with the results of at least one previous survey conducted on a portion of this site (David 1995), and with several other surveys conducted on lands immediately adjacent to it (David 2000a, 2000c, 2004a, 2004c) and with several other surveys conducted on various parcels of land, with like habitat, in the lowland areas in the North Kona District within the recent past (David 1999, 2000b, 2000d, 2001, 2003, 2004b, 2005b, 2005c, 2006a, 2006b).

All but one of the 21 avian species detected during the course of this survey are considered to be alien to the Hawaiian Islands. The lone native species detected, Pacific Golden-Plover is a common indigenous migratory shorebird species, seen throughout the state between July and late April each year. Avian diversity and densities were low, as is to be expected given the fountain grass dominated xeric habitat present on the site and the surrounding property.

Although not detected during this survey it is possible that small numbers of the endangered endemic Hawaiian Petrel (*Pterodroma sandwichensis*), or *ua'u*, and the threatened Newell's Shearwater (*Puffinus auricularis newelli*), or *'a'o*, over-fly the project area between the months of May and November (Banko 1980a, 1980b, Day et al. 2003a, Harrison 1990).

Hawaiian Petrels were formerly common on the Island of Hawai'i (Wilson and Evans 1890–1899). This pelagic seabird reportedly nested in large numbers on the slopes of Mauna Loa and in the saddle area between Mauna Loa and Mauna Kea (Henshaw 1902), as well as at the mid to high elevations of Mount Hualālai. It has, within recent historic times, been reduced to relict breeding colonies located at high elevations on Mauna Loa and, possibly, Mount Hualālai (Banko 1980a, Banko et al. 2001, Cooper and David 1995, Cooper et al. 1995, Day et al. 2003, Harrison 1990, Hue et al. 2001, Simons and Hodges 1998).

Newell's Shearwaters were formerly common on the Island of Hawai'i (Wilson and Evans 1890–1899). This species breeds on Kaua'i, Hawai'i and Moloka'i in extremely small numbers. Newell's Shearwater populations have dropped precipitously since the 1880s (Banko 1980b, Day et al., 2003b). This pelagic species nests high in the mountains in burrows excavated under thick vegetation, especially *uluhe* (*Dicranopteris linearis*) fern.

The primary cause of mortality in both Hawaiian Petrels and Newell's Shearwaters is thought to be predation by alien mammalian species at the nesting colonies (U.S. Fish & Wildlife Service 1983, Simons and Hodges 1998, Ainley et al. 2001). Collision with man-made structures is considered to be the second most significant cause of mortality of these seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on

their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds often collide with manmade structures, and if they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals (Hadley 1961, Telfer 1979, Sincock 1981, Reed et al. 1985, Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998, Ainley et al. 2001). There is no suitable nesting habitat within or close to the proposed project site for either of these pelagic seabird species.

Mammalian Resources

The findings of the mammalian survey are consistent with the results of at least one previous survey conducted on a portion of this site (David 1995), and with several other surveys conducted on lands immediately adjacent to it (David 2000a, 2000c, 2004a, 2004c) and with several other surveys conducted on various parcels of land, with like habitat, in the lowland areas in the North Kona District within the recent past (David 1999, 2000b, 2000d, 2001, 2003, 2004b, 2005b, 2005c, 2006a, 2006b).

One Hawaiian hoary bats was detected as an incidental observation flying down-slope, (*makai*), from above the eastern boundary of the site towards the ocean. This finding was not unexpected as bats are regularly seen *mauka* of the project site and also below the subject property in the Kaloko-Honokōhau National Historical Park and above the Honolōhau small boat harbor on a seasonal basis (Jacobs 1994, David 2006c). Unlike nocturnally flying seabirds, which often collide with man-made structures, bats are uniquely adapted to avoid collision with most obstacles, man-made or natural. They navigate and locate their prey primarily by using ultrasonic echolocation, which is sensitive enough to allow them to locate and capture small volant insects at night.

Very little research into the life cycle, distribution, or population estimates of this species, has been conducted; and much of what has been studied, were small, disconnected, or anecdotal studies as opposed to coherent controlled experiments. Fundamental research into this species distribution and life cycle has just begun (Bonaccorso et al. 2005).

Although only European house mice were detected during the course of this survey it is probable that the other three established *muridae* known from the Island of Hawai'i, roof rat (*Rattus r. rattus*), Norway rat (*Rattus norvegicus*), and possibly Polynesian rat (*Rattus exulans hawaiiensi*) use resources within the subject property at least occasionally. Especially since the site is bound to the north and south by light industrial developments that likely harbor these commensal species.

Potential Impacts to Protected Species

Hawaiian Hoary Bat

As previously discussed, it is likely that Hawaiian hoary bats over-fly the general project area on a seasonal basis. The planting of trees and ornamental vegetation following

development may increase the presence of prey items for this insectivorous bat, and thus may in fact enhance foraging resources for this species in the area.

Hawaiian Petrel and Newell's Shearwater

The principal potential impact that the development of this site poses to Hawaiian Petrels and Newell's Shearwaters is the increased threat that birds will be downed after becoming disoriented by external lights associated with the new development.

Endangered Waterbirds

Although there is no standing water, streams or other water features on the property, and thus the habitat present does not support waterbirds, two listed waterbird species Hawaiian Coot (*Fulica alai*), and the Hawaiian endemic sub-species of the cosmopolitan Black-necked Stilt (*Himantopus mexicanus knudseni*), are resident breeding species within the Kaloko-Honokōhau National Historical Park, which is located directly across the Queen Ka'ahumanu Highway from the northwestern terminus of the project site. The development of this site does not pose direct threats to these species or their habitat, although, the potential exists that the development could pose secondary threats to the National Park and to it's endangered birds if noxious substances such a petroleum, oils lubricants, sewage and the like were to migrate downslope (*makai*) from the project into the Park.

Conclusions

The modification of the current habitat on the site is not expected to result in significant impacts to any avian or mammalian species currently listed as threatened, endangered or proposed for listing under either the Federal, or State of Hawai'i endangered species programs. Furthermore, the development of the site is not expected to have a significant deleterious impact on native faunal resources found within the North Kona District, with the one possible caveat that if noxious substances such a petroleum, oils lubricants, sewage and the like were to migrate downslope, from the project either during construction, or following build-out, into the Kaloko-Honokōhau National Historical Park, the possibility exists that such an event could result in deleterious impacts to two listed waterbird species, Hawaiian Coot and Black-necked Stilt and/or their habitat.

Recommendations

- To reduce the potential for interactions between nocturnally flying Hawaiian Petrels and Newell's Shearwaters with external lights and man-made structures, it is recommended that any external lighting that may be required in conjunction with development of the project be shielded (Reed et al. 1985, Telfer et al. 1987). This mitigation would serve the dual purpose of minimizing the threat of disorientation and downing of Hawaiian Petrels and Newell's Shearwaters, while at the same time complying with the Hawaii County Code § 14 – 50 *et seq.* which requires the shielding of exterior lights so as to lower the ambient glare caused by unshielded lighting to the astronomical observatories located on Mauna Kea.

- To address potential runoff issues and possible secondary impacts to listed waterbird species and their habitat found within the Kaloko-Honokōhau National Historical Park, it is recommended that once a conceptual Master Plan has been developed that the project, consult with both the USFWS and the National Park Service to ensure that implementation of the Master Plan will not result in deleterious impacts to listed waterbird species and their habitat, which is present within the Park.

Glossary:

'A'ā – Clinker lava formed by slow moving lava flows.
Alien - Introduced to Hawai'i by humans.
Ahupua'a – Traditional Hawaiian land division, usually extending from the uplands to the sea.
Commensal – Animals that share humans' food and lodgings, such as rats and mice.
Crepuscular – Twilight hours.
Diurnal – Daytime
Domesticated – Feral species, not considered established in the wild on the Island of Hawai'i.
Endangered – Listed and protected under the ESA as an endangered species.
Endemic – Native and unique to the Hawaiian Islands.
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally.
Muridae – Rodents, including rats, mice and voles, one of the most diverse families of mammals.
Mauka – Upslope, towards the mountains
Makai – Down-slope, towards the ocean.
Nocturnal – Nighttime, after dark.
Pāhoehoe – Sheet lava formed by relatively fast moving lava flows.
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species.
Volant – Flying, capable of flight - as in flying insect.
Xeric – Extremely dry conditions or habitat.

ASL – Above mean sea level.
DLNR – Hawaii State Department of Land & Natural resources.
ESA – Endangered species act of 1973, as amended.
TMK – Tax Map Key.
USFWS – U.S. Fish & Wildlife Service

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Survey of Terrestrial Invertebrate Resources at Kaloko Makai, Kaloko and Kohanaiki, North Kona, Hawai'i Island

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SUMMARY

The Kaloko Makai project site sampled in this biological survey yielded native and adventive arthropods. No invertebrate currently listed as endangered or threatened under either federal or state statutes was located within the survey area.

INTRODUCTION

This report summarizes the findings of an invertebrate[1] survey conducted in support of an environmental impact statement as part of a proposal to construct residential units, areas for retail and commercial use, and supporting infrastructure in North Kona, Hawai'i. SCD Kaloko Makai, LLC, proposes to build on 1,142 acres / 462.2 hectares (h.) of land, within portions of Tax Map Keys: (3) 7-3-009: 017, 025, 026, and 028. This survey was conducted by Steven L. Montgomery, Ph. D., for SCD Kaloko Makai, LLC, as part of a team effort directed by Wilson Okamoto Corporation and Stanford Carr Development, LLC

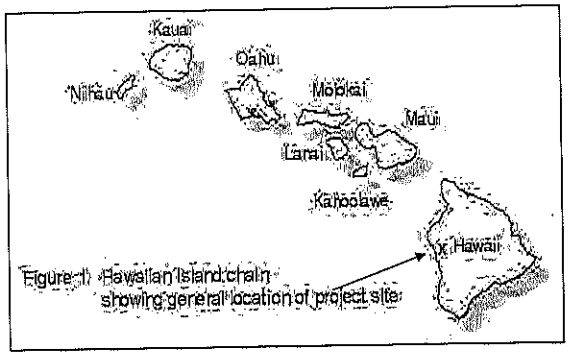


Figure 1. Hawaiian Island chain showing general location of project site

Invertebrates are often the dominant fauna in natural Hawaiian environments. The primary emphasis of this survey was on terrestrial arthropods, particularly those that are endemic or indigenous species, especially those having legal status under either, or both federal and state endangered - threatened species statutes (DLNR 1996, 1997, USFWS 2005a, 2007, 2008).

[1] Animals without backbones: Insects, shrimp, snails, spiders, etc.

Native Hawaiian plant, vertebrate, and invertebrate populations are interdependent. Certain insects are obligatorily attached to host plants and use only that plant as their food. The health of native Hawaiian invertebrate populations depends on habitat quality and absence or low levels of continental predators. Sufficient food sources, host plant availability, and the absence or low levels of introduced, continental predators and parasites comprise a classic native, healthy ecosystem. Consequently, where appropriate in the survey discussion, host plants and some introduced arthropods are also noted.

GENERAL SITE DESCRIPTION

The project area is on the leeward coast of the island of Hawai'i (Figure 1) in the Kaloko and Kohanaiki ahupua'a, North Kona district. The property is approximately one mile mauka of the coastline, between 100 +/- feet (ft.) above sea level (ASL) / 30.5 meters (m.) at the western end to 740 ft. ASL / 213.4 m. at the eastern end. It is bounded by Queen Kaahumanu Highway to the northwest. The makai portion of the property is framed by Kaloko Light Industrial Park, Kohanaiki Industrial Park, and Queen Kaahumanu Highway. The largest part of the property is bisected by Hina Lani Street. (Figure 4).

Figure 2. Typical area of koa haole (*Leucaena leucocephala*) and fountain grass (*Pennisetum setaceum*)

Geologically, the site is mostly pāhoehoe and 'a'ā lavas with lava tubes present throughout the area. Much of the surface is uneven and irregular. The site incorporates several vegetation communities, from a nearly intact lowland dry forest to scrub dominated by koa haole (*Leucaena leucocephala*) or by Christmas berry (*Schinus terebinthifolius*) (Figure 2). Biologically the most interesting area is the "open to closed native forest occurring on the relatively recent lava flow comprising most of the central portion of the southern half of the study area" (Figure 3) (Whistler 2006). The area was recognized as Management Unit 10 in the US Fish & Wildlife Service's *Recovery Plan for the Big Island Plant Cluster* (1998). This dry forest area has supported several native Hawaiian plants of interest as hosts or shelter for native invertebrates.

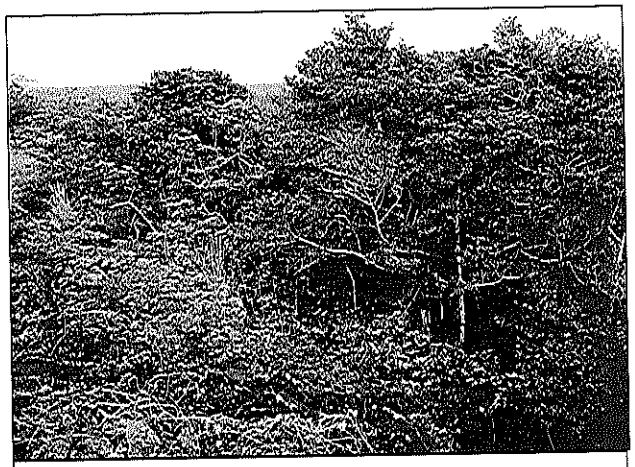


Figure 3. Typical native dry forest area on 'a'ā lava flow.

The larger site has been through a variety of changes as first Polynesians then Europeans adapted the area to their own needs. Early Hawaiian cultivation of crops, water collection in lava tubes, and establishment of housing began the process of change. Historic grazing of domesticated and feral animals, and more recent bulldozing (Bell et al. 2008a, b, c; Esh 2008) all combined to replace large portions of the native vegetation - and native invertebrate population - with a succession of introduced plants and animals (Whistler 2006; David 2006). The bird and mammal survey found evidence of 20th century host plant damaging goats, sheep, and pigs in the area (David 2006).

There are no natural year-round surface sources of fresh water that would support specialized invertebrates. Some of the lava tubes were used into the historic period for collection of dripping fresh water (Bell et al. 2008a, b, c; Esh 2008).

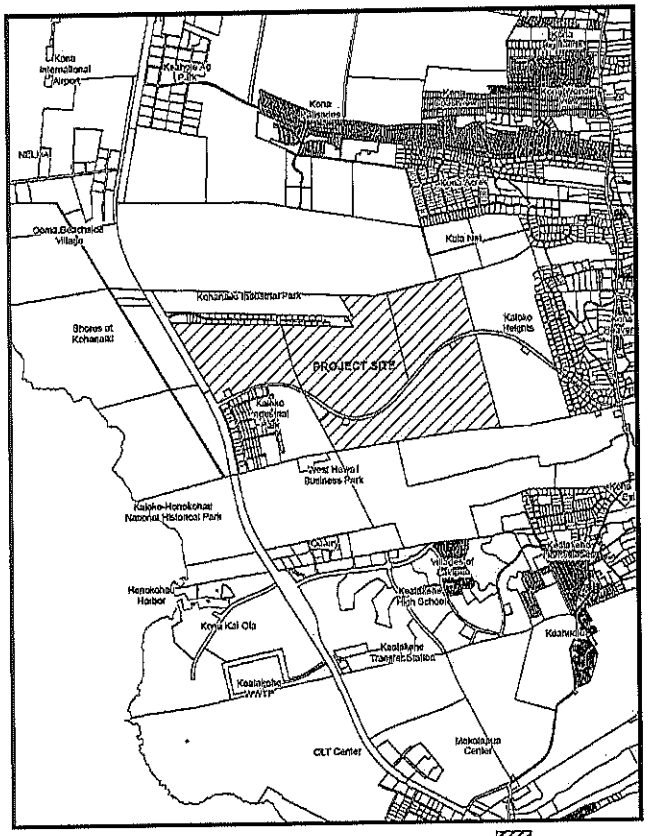


Figure 4. Map showing North Kona, Hawai'i, location of project site ▨.

[from Wilson Okamoto 2007, Figure 1-4]

INVERTEBRATE SURVEY METHODS

Since 1970, I have taken part in field projects at other locations in the Kailua-Kona area and in other dryland locations throughout the island chain. Surveys of other dryland areas have created a sizeable body of information on native invertebrate and related botanical resources found in areas similar to Kaloko Makai (Bridwell 1920, Swezey 1935). Those experiences and the results of those surveys provided the basis for my study design and my analysis of results.

Previous Surveys and Literature Search

Botanical surveys of the project area have been conducted since at least 1983 (Nagata 1983). A previous Environmental Impact Statement associated with this site (Kimura 1996) was reviewed. Recent avian, mammalian (David 2006), and botanical surveys (Whistler 2006) also were very helpful in preparing for this study. None of the previous studies referenced terrestrial invertebrate surveys or surveys of lava tubes for cave-adapted invertebrate species.

Recent archaeological studies (Bell et al. 2008a, b, c; Esh et al. 2008) showed evidence of extensive lava tubes in the project area, but no mention of cave-adapted invertebrate species.

Searches were made in the Bishop Museum Library, University of Hawai'i Hamilton Library, and State's Office of Environmental Quality Control web site (2008). Surveys done for other projects in the general area were reviewed (Char 1986, 1990, Geometrician 2003; Helber et al. 1986, 1991a, 1991b; PBR 1991, 2007, 2008; Towill 1976, 1988; Wilson Okamoto 2000). Only the planning for Kula Nei, a nearby mauka project, included a survey of lava tube invertebrates (Howarth 2006, SWCA 2006-7).

A search was made for independent studies of invertebrates associated with this site or with nearby sites. Online proprietary data bases of such as AGRIS, Biological Abstracts, Ingenta Connect, and Zoological Record also were searched. Searches were made for publicly available articles mounted on the web (Goggle Scholar) and in regional and national databases which provide geographic access, such as the Pacific Basin Information Node and Hawaii Natural Heritage Program. Data base searches were made in Bishop Museum's Arthropod Checklist, and the University of Hawaii, Hamilton Library's Hawaii-Pacific Journal Index. Access to the project area was limited prior to construction of Queen Ka'ahumanu Highway. The bulldozing of a jeep road by Huehue Ranch in 1955 gave access to part of the property, but travel was mostly through the subject area to reach ocean resources (Bell et al. 2008a). The area lacked

the commercial agriculture which generated much of Hawaii's formal entomological surveys since the 1900s. The combination of these factors makes it unremarkable that this review showed no previous independent invertebrate surveys of the area.

The US Fish & Wildlife Service has demonstrated an interest in the native dry forest area of the property for many years. Since 1995 USFWS personnel have surveyed the property at least once (USFWS 1997). As a part of our literature search a Freedom of Information Act Request (FOIA) was initiated with USFWS regarding those surveys and records were obtained. Unfortunately, detailed cave by cave records were not found. The information resulting from the FOIA request is incorporated in several places in this report.

Fieldwork

Field surveys were conducted in September and October 2008. I conducted a general assessment of terrain and habitats at the start of the survey. Surveying efforts were conducted at various times of day and night, a technique which is vital for a thorough survey. Native botanical resources identified by Nagata (1983), Whistler (2006), and US Fish & Wildlife Service records (see "Previous Surveys and Literature Search" above) were an important focus of my searches, as were lava tubes located by the archaeological survey (Bell et al. 2008a, b, c; Esh et al. 2008).

Fieldwork schedule:

September 12-15, 2008	Site examination, orientation, collecting; light survey
September 28-30, 2008	
October 1-4, 2008	General collecting; light survey; lava tubes surveys
October 7, 2008	Lava tube orientation; general collecting; light survey
October 8-10, 2008	General collecting; light survey; lava tubes surveys

Daylight surveying was concentrated during the cooler early morning and late afternoon hours when temperatures are lower and invertebrates would be more active.

See Figure 7 for light surveying locations within the survey area.

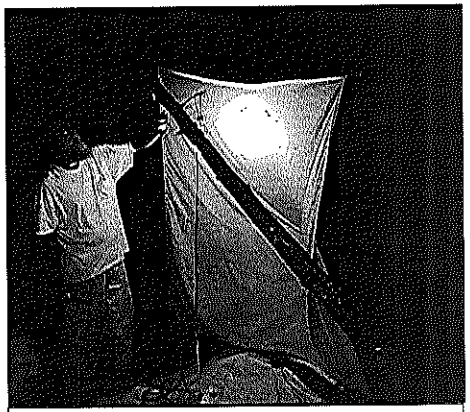
Collecting Methods

The following collecting methods for terrestrial invertebrates were used as appropriate to the terrain, botanical resources, and target species.

Baiting: Baits are used to attract insect species to specific tastes or smells. For example, some flies come to dead or dying plants with a specific odor. Baits can mimic that smell and taste and so attract those insects. Insects are enticed by the bait's 'advertisement.' Baits are placed at likely locations or inserted in bottle traps and checked periodically. Any insects at the bait are then observed and collected if appropriate. This is much more efficient than roaming the research area seeking cryptic insects. Baiting is a recognized method of censusing lava tubes for cave adapted fauna.

Lava tubes were chosen for baiting from among tubes located in my own work and in the previous archaeological surveys. In choosing lava tubes for baiting I excluded from my survey all lava tubes which archaeological surveying had shown contained human remains and those chosen for preservation. Also excluded were tubes with multiple skylights or a short dark zone. Tubes were chosen for baiting based on the size of the dark zone, presence and amount of intruding roots, and dampness which experience shows create a lava tube environment suitable for cave fauna. Traps used shrimp paste and blue cheese baits, both proven and durable attractants in other lava tube surveys. Baited traps were placed in 3 lava tubes October 10 and retrieved on October 13, 2008.

Host plant searches: Potential host plants, both native and introduced, were searched for arthropods that feed or rest on plants. Wandering transects were followed throughout the inland area with emphasis on reaching native host plants.



© Figure 5. A light census is important to understand the invertebrate fauna.

Light sampling: A survey of insects active at night is vital to a complete record of the fauna. Many insects are only active at night to evade birds, avoid desiccation

and high temperatures, or to use night food sources, such as night opening flowers. Light sampling uses a bright light source in front of a white cloth sheet (Figure 5). Night active insects seem to mistake the collecting light for the light of the moon, which they use to orient themselves. In attempting to navigate by the collecting light, confused insects are drawn toward the light and land on the cloth in confusion. This type of collecting is most successful during the dark phase of the moon or under clouds blocking starlight. Most moths and other night fliers are not capable of very distant flight. Consequently, light sampling does not call in many insects from outside the survey area.

Sampling was conducted for approximately 11 hours on each night of surveying. The light source was a mercury vapor (MV) bulb. An additional, UV light source was used at all sites. Every effort was made to diminish competing light from

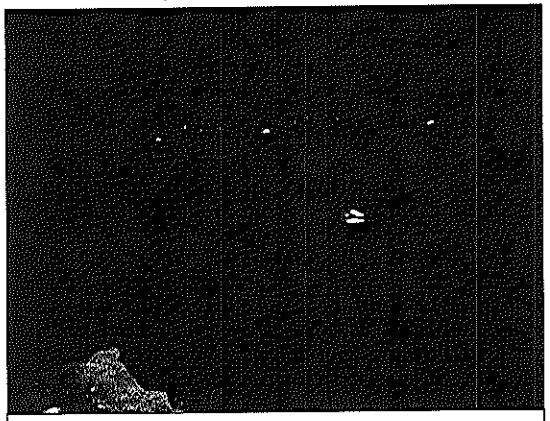


Figure 6. Monitoring locations [blue light] were located away from competing light sources [background] to the extent possible.

housing, street lights and other artificial sources (Figure 6), but these were a factor in response success at some locations.

Locations were chosen based on experience, host plant proximity, and terrain. The botanical survey placed most of the native plants in the dry land forest area. As the interconnection of arthropods and host plants would predict, light sampling in that area yielded the most native arthropods. All light sample locations are marked on Figure 7.

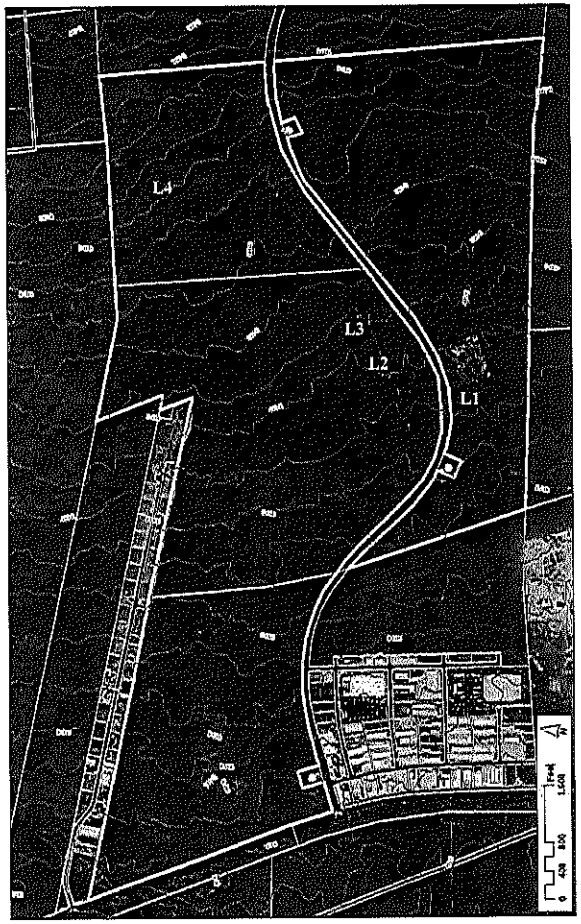


Figure 7. Map of Kaloko Makai project area showing light monitoring sites, lava tube.

= light monitoring = lava tube

Sweep nets: This is a most common and general method of collecting most flying and perching insects. A fine mesh net was swept across plants, leaf litter, rocks, etc. to collect any flying, perching, or crawling insects. Transfer from the net was either by aspiration, or by placing the net contents into a holding container.

Visual observation: At all times, I was vigilant for any visual evidence of arthropod presence or activity. Visual observations provide valuable evidence and are a cross check that extends the reach of sampling techniques. Visual observation also included turning over rocks, examining dead wood, and other debris.

Survey Limitations / Conditions
My ability to form advisory opinions is influenced in the following ways:

Collecting conditions:

Weather: Weather was favorable for surveying during each field day. The atmospheric vog did not appear to alter the behavior of invertebrates.

Seasons: Monitoring at a different time of the year might produce a longer or different arthropod list. Weather and seasonal vegetation play an especially important role in any survey of invertebrates. Many arthropods time their emergence and breeding to overlap or follow seasonal weather or to coincide with growth spurts of an important plant food. Host plant presence/absence, and seasonal changes, especially plant growth after heavy rains, affect the species collected.

Although there were some small rains in the weeks prior to this survey, true winter rains and vegetation revitalization had not taken place. If vegetation had developed after winter rains, a different insect list might have resulted. Nevertheless, the low level of native plants outside the dry forest zone was a stronger factor in determining the invertebrates encountered than the season or condition of vegetation.

Moon: The moon presented competition to the collecting light on the evenings of September 12-13-14, 2008. The moon rose between 4 and 5 p.m. each night[2] and set between 3 and 4 a.m. the following morning. The moon was described as "waning gibbous" with 85-90% of the Moon illuminated. (USNO) The relative lack of artificial light sources at the chosen sites compensated to a degree for the competition.

The moon did not present any competition to light collecting efforts September 28-October 2, and relatively little on October 3 and 4. At the start of fieldwork, the moon rose during daylight hours and then set before dark. At the end of fieldwork the moon was setting in the early evening 8:00-830 p.m., continuing to provide many moon-free hours for light surveying (USNO) During the short period the moon was 'up,' it presented small competition to my bright light in the largely unlit parcels under study.

Limited duration: Surveying for a longer period of time might enlarge the list of species; however, I believe the survey provides a fair review of the invertebrates present.

Selectivity: My survey was focused on finding any endemic and indigenous Hawaiian land invertebrates species. No attempt was made to collect or completely document the many common alien arthropod species present.

The exclusion of lava tubes based on cultural content and human remains did limit the choice of tubes. A thorough review of color photographs of lava tube interiors and faunal remain listings provided in the archaeological reports (Bell et al. 2008a, b, c; Esh et al. 2008) allowed a useful review of some aspects of the lava tube setting in the excluded tubes (see Lava Tube Species page 20).

RESULTS:
Incidental records:
In addition to the invertebrate results noted below, rats were present as shown by their destruction of kukui seeds (*Aleurites moluccana*). The small Indian mongoose (*Herpestes auropunctatus*) was seen at various locations on the property.

[2] Times given are for Kailua-Kona as closest city tracked by U. S. Naval Observatory

DISCUSSION

Native species of note are discussed. Also, information is provided on adventive species often misidentified by the public, especially those confused with native species. Non-native species in conflict with native species or human beings are discussed.

INVERTEBRATE RESOURCES

ARTHROPODS

CRUSTACEA

DECAPODA (Shrimps, Lobsters, Crabs, Crayfish)

Undetermined species

Parts of three individual crabs (Figure 8) were seen in one lava tube. The examples observed in the lava tube did not appear to be part of any midden. Photographs of the specimens are under review by specialists to determine the species. Further information will be provided as it becomes available.

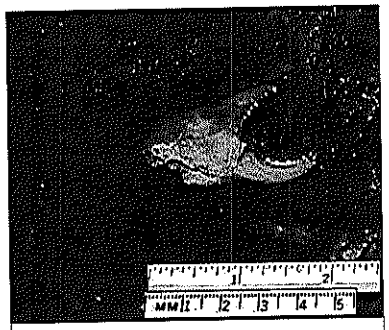


Figure 8. Crab remains seen in several tubes.

ARANEAE (spiders)

Dysderidae: *Dysdera crocota* C L Koch, 1838

This small spider (10-14 mm), known to bite humans, was seen on the floor of a lava tube.

Salticidae: Unidentified species

One immature jumping spider was noted under stones on the inland lava flow. Identification of immatures from one sample is extremely difficult. There are 9 spiders of the family Salticidae reported from Hawai'i Island, four endemics, all of the genus *Sandalodes*, and 5 adventive or introduced spiders. (HBS 2002a, Nishida 2002)

Scytodidae: *Scytodes* sp. or spitting spider

There are three adventive species known on Hawai'i Island: *S. fusca*, *S. longipes*, and *S. striatipes*. This genus gets its common name from the hunting method of spitting strands of silk from its fangs to fasten down prey for easy dining. (Mascord 1970)

INSECTA

HETEROPTERA (True bugs)

Lygaeidae: *Nysius* sp.

This native seed bug, commonly found in dryland locations, uses many alien and native host plants. It is known from most islands in the Hawaiian chain.

LEPIDOPTERA (butterflies, moths)

Cosmopterigidae: *Hyposmocoma* sp.

Two species of *Hyposmocoma*, as caterpillars, were found in the rocky habitat (Figure 9) and three species, in adult stage (Figure 11), came to light. Considering the population is likely at a low level due to the dry weather, the diversity is noteworthy. In the wet season it could be expected that a higher number of individuals and more species would be recovered. *Hyposmocoma* are called "case bearers" because after an early beginning inside a leaf curl or similar hiding place, the caterpillars create protection in an intricately constructed portable "cave" woven of their own silk. For camouflage, they add bits of their surroundings to the case using silk: snips of dry grass or leaves, flakes of bark, a little dirt (Figure 10). The case is then easily mistaken by a predator as

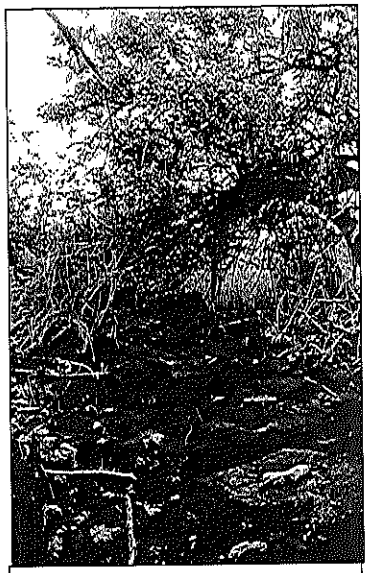


Figure 9. *Hyposmocoma* casebearers were found by lifting up slabs of broken pahoehoe.

another part of the inedible landscape. These bunkers are fitted with a hinged lid (operculum), pulled shut by tiny mandibles to defend them from enemies. Their relationship to the case is similar to that of a hermit crab to his shell. They are dependent on their case, and die if removed – even if protected from predators and given food. They don't move far, but feed while partly emerged from the case, dragging along protective armor by their six true legs. Cases are sometimes attached to rocks or tree trunks and foliage. (Manning/Montgomery in Liittschwager & Middleton 2001)

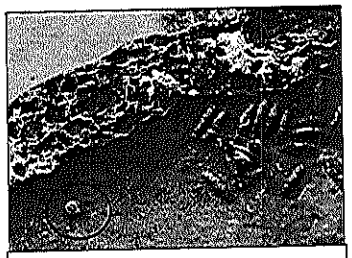
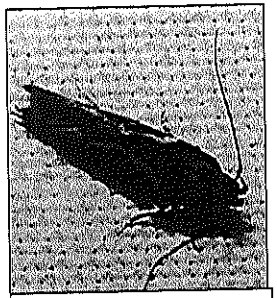


Figure 10. *Hyposmocoma* caterpillars sheltered under rocks. Far left, a pseudoscorpion shared the habitat.



© Figure 11. *Hyposmocoma* sp.
Photo# starr-030724-0089
credit: "Forest & Kim Starr" (HEAR)

With over 500 kinds, *Hyposmocoma* micromoths are the greatest assemblage of Hawaiian island moths, showing astonishing diversity. After writing 630 pages on them, Dr. Elwood Zimmerman lamented the inadequacy of his study. He noted an enormous cluster of species with explosive speciation and diverging radiation (Zimmerman 1978). Much remains to be learned about the life ways of this interesting group of insects now under study by University of Hawaii's Dr. Daniel Rubinoff and his students (Rubinoff & Haines 2006).

Crambidae (grass moths)

Tamsica hyacinthina (Meyrick 1899)

This was the most common native species found during the survey. The caterpillars feed on a wide variety of grasses, allowing them to adapt to the changing flora at Kaloko. The genus was described by E. C. Zimmerman as "a cluster of poorly understood, obscure, difficult little species." (1958) Pioneering biologist R. C. L. Perkins noted "They are able to flourish in the driest localities near the coast...." (Perkins 1913).

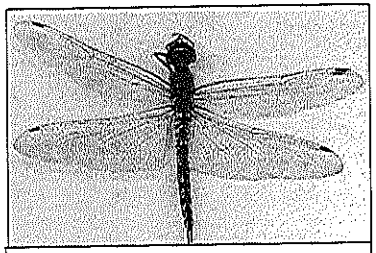
Gracilariidae:
Caloptilia mabaella (Swezey), 1910 or *Caloptilia azaleella* (Brants), 1913

Figure 12. Lama (*Diospyros sandwicensis*) or Hawaiian persimmon at Kaloko dry forest showing damage by leaf miner *Caloptilia* sp.

The young and terminal leaves of lama trees (*Diospyros sandwicensis* or Hawaiian persimmon) in the dry forest area at Kaloko Makai show distinctive feeding damage associated with leaf miner caterpillars (Figure 12). Leaf miners burrow or "mine" inside a leaf, creating scars or bumps on the leaf surface where they have eaten out the inner flesh of the leaf. The most likely adventive pest is *Caloptilia* sp. *C. mabaella*, which has been known in the islands since 1910 (Swezey 1910, 1954), is previously recorded only from O'ahu. *Caloptilia azaleella* is known from O'ahu and Hawai'i island, but not previously associated with *Diospyros sandwicensis*. (HBS 2002a; HOSTS 2008; Nishida 2002)

Noctuidae: *Schrankia* sp.
This small moth was previously noted in the lava tubes of Kaloko by US Fish & Wildlife Service personnel (USFWS 1997) and was found by this survey as well. The genus is very complex. As noted by Dr. F. G. Howarth (2006): "There are often 2 or 3 morphs in each cave that show different degrees of cave adaptation..."

ODONATA (Dragonflies and Damselflies)
Libellulidae: *Pantala flavescens* Globe skimmer



© Figure 13. Globe skimmers often use human created water sources

This indigenous dragonfly (Figure 13) was observed on the property. Among the most easily observed native insects, they are large, easily approached by people, and graceful in flight. Any small amount of fresh water will attract them and they often colonized human maintained water sources such as golf-course water hazards and stock tanks. Globe skimmers are widely distributed throughout the Hawaiian Islands, from Kure to Hawai'i Island (HBS 2002a, Nishida 2002) and have even been found flying at sea (Howarth & Mull 1992).

ORTHOPTERA (Praying Mantis, Grasshoppers, Crickets)
Gryllidae
Gryllodes sigillatus (Walker), 1869 Flightless field cricket
This world-wide traveler was first recorded in the Hawaiian Islands in 1895 (Zimmerman 1948). In the years since, it spread up and down the island chain.

Although superficially similar in appearance, *Gryllodes sigillatus* males can 'sing' by rubbing vestigial wings together, while the native species, *C. anahulu* (see page 25), is mute.

Table 1: List of Invertebrates:[3] Kaloko Makai, North Kona, Hawai'i

Species	Common Name	Status	Abundance	Notes
ARTHROPODA				
ARACHNIDA				
ARANEAE	spiders			
Dysderidae				
Dysdera crocota C L Koch, 1838		Adv	U	in lava tube
Heteropodidae				
Heteropoda venatoria	large brown spider cane spider	Adv	U	leaf litter
Salticidae	jumping spider			
unidentified immature		?	U	under stones
Scytodidae				
Scytodes sp.	spitting spider	Adv		in lava tube
PSEUDOSCROPIONIDA	pseudoscropions			
unidentified species 1		?		sheltering with casebearers
SCORPIONES	scorpions			
Buthidae				
Isometrus maculatus (De Geer)	lesser brown scorpion	Adv	U	in lava tube
CRUSTACEA				
DECAPODA	Shrimps, Lobsters, Crabs, Crayfish			
Coenobitidae:	Crab			
Coenobita sp.				
INSECTA				
BLATTODEA				
Blattidae	cockroaches			
Periplaneta americana(Linnaeus), 1758:	American cockroach	Adv	C	in lava tubes
COLLEMBOLA	springtails			
Entomobryidae				
undetermined sp. 1		?	R	under stones
HETEROPTERA	true bugs			
Lygaeidae	seed bugs			
Nysius sp.		End	O	at light
HOMOPTERA	planthoppers			
Cixiidae				
Oliarus sp.		End	R	*Reynoldsia* bark

[3] Names authority: Hawaii Biological Survey 2002a; Nishida 2002; Zimmerman 1948-80; Zimmerman 2001

Table 1: continued

Species	Common name	Status	Abundance	Notes
HYMENOPTERA	wasps, bees, ants			
Apidae				
Ceratina smaragdula (Fabricius)	small carpenter bee	Adv	U	at *Sophora*
Formicidae	ants			
Camponotus variegatus	carpenter ant	Adv	C	to light
Pheidole megacephala (Fabricius, 1793)	big-headed ant	Adv	C	on soil
Anoplolepis gracilipes (F. Smith, 1857)	longlegged ant	Adv	C	on soil
Vespidae	wasps			
Polistes exclamans Viereck, 1906	common paper wasp	Adv	C	at flowers
LEPIDOPTERA				
Cosmoptorigidae	case bearers			
Hyposmocoma sp. 1	slender wedge case	End	R	under stones
Hyposmocoma sp. 2	broad case	End	U	under stones
Hyposmocoma sp. 3	black, pointed adult	End	A	at light
Crambidae (Pyralidae)	micro-moths			
Mestolobes sp.		End		at light
Orthomecyna sp.		End		at light
Tamsica hyacinthina (Meyrick 1899)		End	A	at light
Noctuidae				
Schrankia		End	O	in lava tube
Olethreutidae				
Cydia latifemoris (Walsingham, 1907)		End	O	reared from *Sophora* seeds
Plutellidae				
Plutella nohollo Robinson & Sattler, 2001		End	R	at light
Plutella xylostella (Linnaeus, 1758)		Adv	C	at light
Xyloryctidae				
Thyrocopa abusa Walsingham, 1907		End	R	in leaf litter, twigs uhiuhi
ODONATA	dragonflies; damselflies			
Libellulidae	skimmers			
Pantala flavescens (Fabricius, 1798)	globe skimmer	Ind	C	in flight

Table 1: continued

Species	Common name	Status	Abundance	Notes
ORTHOPTERA	praying mantis, grasshoppers, crickets			
Gryllidae	crickets			
Gryllodes sigillatus (Walker)1869	flightless field cricket	Adv	A	on lava
CHILOPODA				
SCOLOPENDROMORPHA				
Scolopendridae	centipedes			
Scolopendra subspinipes Leach, 1815	large centipede	Adv	U	on soil

Status:
End endemic to Hawaiian Islands
Ind indigenous to Hawaiian Islands
Adv adventive
Pur purposefully introduced
? unknown

ABUNDANCE = occurrence ratings:
R Rare seen in only one or perhaps two locations.
U Uncommon- seen at most in several locations
O Occasional seen with some regularity
C Common observed numerous times during the survey
A Abundant found in large numbers
AA Very abundant abundant and dominant

Lava Tube Species

The lava tube survey yielded a few native invertebrates, with *Schrankia* sp. a moth, being the most common native species encountered. The most common arthropod encountered in the small sample of lava tubes surveyed was the adventive *Periplaneta americana* (American cockroach). These results are not surprising given that many of the lava tubes have skylights creating a short dark zone, or none at all (Figure 14). Some tubes lack covering vegetation. In many tubes there is no root system reaching into the lava tubes, and insufficient moisture to support a richer ecosystem. Other tubes have only a few grass roots (Figure 16). The major food source, long roots, (Figure 15) supporting most lava tube arthropod communities, is mostly absent.

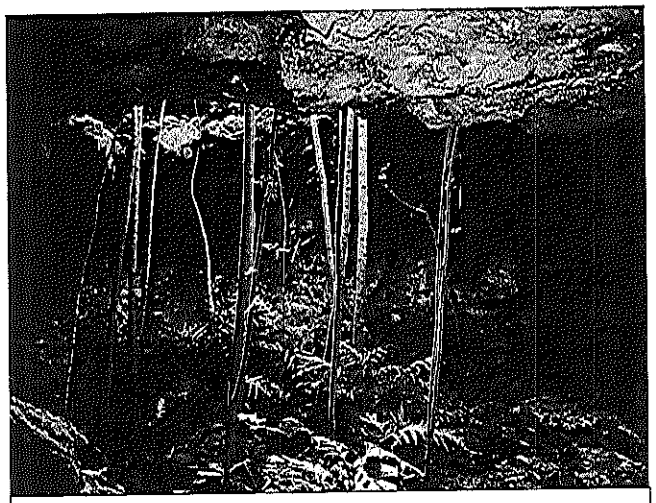


Figure 14. Skylights or openings to the outside, common in the Kaloko tube system, make many of the tubes too dry and too bright for a healthy dark-adapted cave ecosystem.

My examination of a small sample of lava tubes was augmented by a thorough review of color photographs taken inside numerous tubes and of faunal remains listings provided in the archaeological reports (Bell et al. 2008a, b, c; Esh et al. 2008). The images in those reports with very few exceptions show the lava tubes surveyed by archaeologists displaying no descending roots, or short roots.

In wetter lava tubes at other locations, large portions of the wall surface may be covered with a slime, on which the larvae of crane flies (*Limonia* sp.) leave characteristic trails. My review of the small patches in my sample caves (Figure 17) and of the color photographs in the archaeological reports (Bell et al. 2008a, b, c; Esh et al. 2008) shows no evidence of the baseball-stitch pattern (Figure 18) left by the feeding of the larvae of crane flies (*Limonia* sp.). Factors affecting the suitability of a habitat for *Limonia* include low humidity and apparent reduced nutritional content in the coating (Howarth 1973). Kaloko Makai tubes present both low moisture and few overhead plants with descending roots.

My findings seem to parallel those from a 1995 US Fish & Wildlife Service visit to some of the tubes. Fish & Wildlife representatives entered 25-30 caves as part of a survey of the property's dry forest area. US Fish & Wildlife Service reported most caves lacked aspects recognized as necessary to support cave-adapted ecosystems. Moisture levels were low and root penetration into the lava tube system was lacking. Although 6 caves looked more promising, only one species of *Shrankia* moth was seen in those caves. (USFW1997)

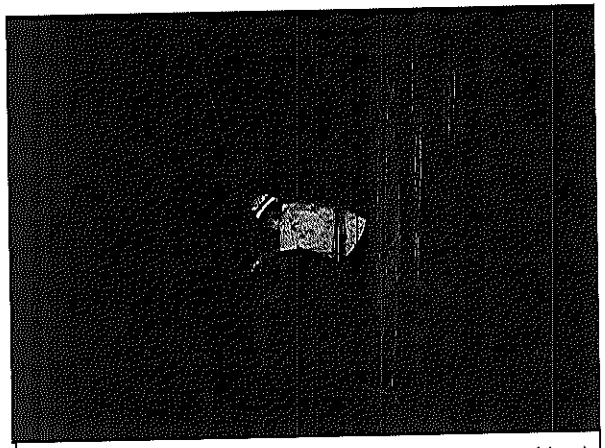


Figure 15. To support a thriving lava tube ecosystem a typical cavern (above) needs a large number of long and healthy roots penetrating from overhead vegetation.

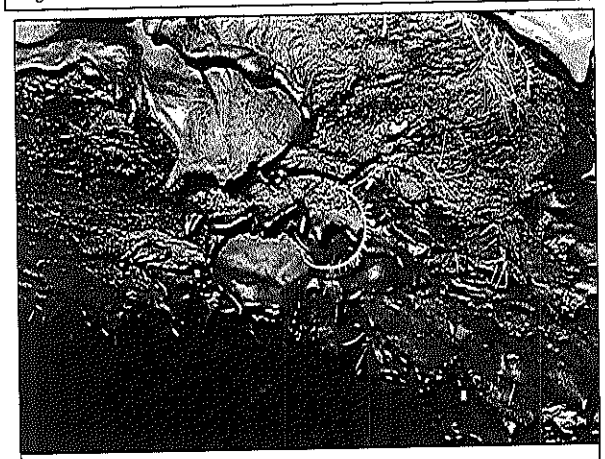


Figure 16. Typical view of short roots penetrating Kaloko Makai lava tubes.

Figure 17. Typical view inside Kaloko lava tube. Slime coverings (white patches) were sporadic and showed none of the patterns created by feeding endemic crane fly larvae (example below).

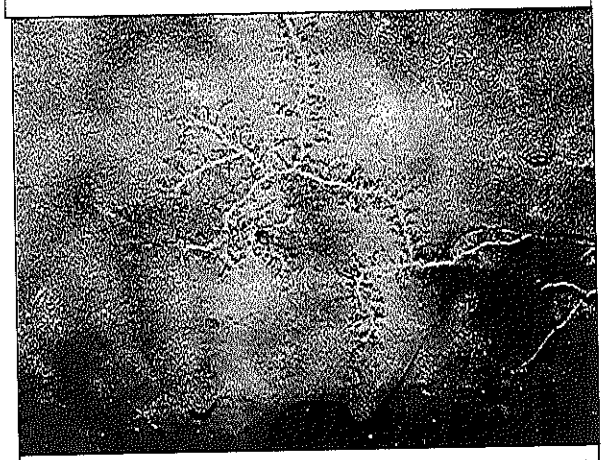


Figure 18. In wetter lava tubes large portions of the surface may be covered with a slime, on which the larvae of crane flies (*Limonia* sp.) leave characteristic trails. © near volcano Feb 2008

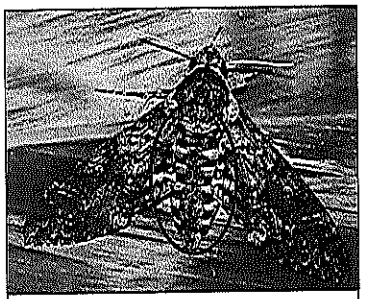
Invertebrates Not Present
Alien predatory ants are a major cause of low numbers of native arthropods. The big-headed ant (*Pheidole megacephala*), longlegged ant (*Anoplolepis gracilipes*), and carpenter ant (*Camponotus variegatus*), which prey on other insects (Zimmerman 1948-80), are present on the property. Ants are well documented as a primary cause of low levels of native arthropods at elevations up to 2000 ft. (Perkins 1913). On all nights, during light censusing, ants quickly appeared and began attacking the resting moths and smaller insects at my light. Ant populations often do not overlap. Rather they have separate territories, effectively apportioning the hunting grounds between themselves, offering few ant-free zones to native arthropods.

MOLLUSCA
Gastropoda (Snails) Pulmonata
No native snails were observed on the project property.

ARTHROPODA
Diptera: Drosophilidae: *Drosophila*

No native *Drosophila* (picture-winged flies) were observed on the property. The location does not provide appropriate habitat for any of the 12 native *Drosophila* species recently listed as endangered or threatened. (USFWS 2006a, b).

Lepidoptera: Sphingidae:
Agrius cingulata Sweet potato hornworm



© Figure 19. Sweetpotato hornworm showing pink markings.

The sweet potato hornworms feed on all sweet potato, morning glory, and related plants. Although it did not respond to my light survey, it is very likely to be seen on the property as it is widely distributed around the Hawaiian Islands and appropriate host plants are present. (HBS 2002a, Nishida 2002) This large and easily seen moth is most easily confused by the public with the Blackburn's sphinx moth (*Manduca blackburni*) described below. The adult *A. cingulata* having PINK markings (Figure 19) along both sides where *Manduca* has orange (Figure 20). When the moth is at rest with wings folded, these color markings are hidden, leading to possible misidentifications.

Manduca blackburni
Blackburn's sphinx moth (*Manduca blackburni*), (Figure 20) an endangered species (Fed Reg 1999-2000) which favors leeward slopes, was not found in this survey. Neither the moth's solanaceous native host plant, 'aiea (*Nothocestrum* sp.), nor the best alien host, tree tobacco (*Nicotiana glauca*), were observed on the property in my own survey or the most recent botanical survey (Whistler 2006). *Capparis sandwichiana*, reported to be adult nectar plants is known on the property. Whenever the plants were encountered in my surveying, I was alert for adults feeding on blooming flowers. *Manduca* was not observed.

© Figure 20. Blackburn's sphinx moth is distinguished from other hawk moths by orange markings.

Although the original *Recovery Plan* (USFWS 2005b) for this large sphinx moth proposed two small management areas in North Kona, Hawai'i, the *Final Rule* (USFWS 2003) designated habitat only at the more inland location, Pu'uwa'awa'a.

Orthoptera: (Praying Mantis, Grasshoppers, Crickets)
Gryllidae
Caconemobius anahulu Otte, 1994 Lava cricket
This species was first discovered by Dr. D. Otte on barren lava 1 km from 'Anaeho'omalu Bay, Hawai'i Island. In his major revision of Hawaiian crickets Otte writes this species "may be widespread along the western slopes of Hawaii Island." (Otte 1994) It is much less common than *Gryllodes sigillatus* (see page 16) in these extremely barren lavas at Kaloko Makai. Although not found in this survey, it is likely a longer search at another time of year would have recovered this species.

Medically important species

The Kaloko Makai project area includes classic habitat for centipedes, scorpions, and widow spiders, so these medically important species may be present in the area. *Dysdera crocota* , a 10-14 mm spider known to bite humans (page 12), and scorpions were seen inside the lava tubes and in the rocky areas. Common paper wasps (*Polistes exclamans*) (Figure 21) were seen repeatedly on the property. Employees should be alert for these species when working in the area. These species may pose a serious risk to some individuals, and supervisors should be aware of any special allergy of employees. Some individuals can experience anaphylactic reactions to venom. Also note that the ant species reported present (see page 24) are known to bite people. When moving stones or piled brush, use of gloves and long sleeves will greatly reduce the risk of accidental contact and bites with all species noted here. Please see *What Bit Me?* (Nishida & Tenorio 1993) and *What's Bugging Me?* (Tenorio & Nishida 1995).

© Figure 21. Paper wasp

POTENTIAL IMPACTS

Potential Impacts on Native, Rare, Federally or State Listed Species

No federally or state listed endangered or threatened species were noted in this survey (USFWS 2008). No anticipated actions related to the proposed project activity in the surveyed locations are expected to threaten an entire species.

RECOMMENDATIONS

Data retrieval

Decapoda

As the presence of the crab remains I observed in my survey had been marked by the archaeological surveyors, they were not collected. A consultation with B. P. Bishop Museum specialists shows that no specimens of this sort have been closely examined by scientists knowledgeable in this group. As the examples in these caves are in relatively good condition, they should be retrieved for specific identification by invertebrate specialists as part of the archaeological data recovery and mitigation process. During data retrieval, a search should be made for additional parts of the crab to aid in identification (i.e., lifting rocks, looking for smaller parts of the crab). Proper and specific identification will provide valuable information to increase both biological and cultural knowledge.

Prevent habitat degradation:

Fulfillment of the plan to preserve some archaeological sites and parts of the dry forest habitat should assist native invertebrate species, including cave adapted species. Selective removal of alien plants in these areas can assist native plants in filling the available niches. Additionally, it is important to prevent establishment of new competitive or predatory alien invertebrate species.

A **Best Practices Management Plan** for construction should be written and implemented specifying methods and controls for the entire construction zone to prevent or minimize runoff, spills, and impact on the makai coastal habitats (Kaloko-Honokōhau National Historical Park) as well as fragile archaeological and biological zones within the property. Establish construction staging areas and storage of materials well away from the fragile areas.

Two factors influence establishment of alien species: access and regular food sources.

Inspect construction materials for hitchhiking seeds or animals.

Clean tools, boots, and equipment used at other sites to minimize the chance of transporting new pest plants or animals to the area. Soil packed in tires, on helicopter runners, or workers' boots can transport seeds, and insect or snail eggs. Ants, snails and slugs, and many other invertebrates can hide in boxes or equipment resting at one location and later be carried to Kaloko Makai.

When establishing plantings after construction, care should be taken to prevent alien plant or animal species from being introduced on the plantings or associated soil.

Remove trash regularly. Predatory species such as ants easily establish in areas where food trash is consistently available. Food trash during construction can increase mongoose (*Herpestes auropunctatus*) populations as well. Construction workers are socialized to simply drop food remains and food wrappers, bottles and containers. Change expectations: Provide trash cans, establish a culture of using them, and empty the cans frequently.

Shield external lighting:

We concur with the advice of David (2006) to shield outdoor lighting. Light is attractive to all arthropods (see *Methods* page 7). The potential presence of *Manduca blackburni* in the greater area makes shielded lighting an important protection for this endangered invertebrate.

Landscape with native dryland plants for lower cost maintenance:

We concur with the advice of Whistler (2006) to revegetate public and common areas with native dryland adapted plants. Given the Kona climate of the project area, it would be both practical and appropriate. Native plants would provide habitat for native arthropods, while creating interesting areas for walking, cultural learning, nature study, and bird watching. Importantly, using dryland plants to landscape can lower long-term watering costs and water draws, following an initial establishment period. Native plants will remain green and thus more fire resistant throughout the summer. Most native plantings will have lower human maintenance costs as well (less hedge trimming, weed whacking). Planted in a mix of ground cover, shrub, and tree heights native plants also help slow run off and retain moisture when rains do come. Native plants usually grow well without the use of fertilizers, reducing the potential for runoff into Kaloko-Honokōhau National Historical Park (David 2006). Native insects will find this refuge over time. The plantings will provide educational, visual, and aesthetic benefits to residents while conserving water at very low on-going cost.

Home buyers should be given guidance on xeriscaping with restrictions being considered as part of covenants or homeowner association rules. Plants that are adapted to dryland areas also will not require doses of fertilizer and pesticides and so reduce non-point pollution. Several southwestern U. S. continental cities have long enforced water / yard planting restrictions due to water concerns. Their experiences may prove helpful in planning.

Resources helpful in understanding Hawaiian plants in an urban setting include *Native Hawaiian Plants For Landscaping, Conservation, and Reforestation* (Bornhorst & Rauch 1994) and *Growing Native Hawaiian Plants* (Bornhorst 2005). By prior arrangement with growers, native Hawaiian plants can be as convenient to mass plant as the introduced plants commonly used to re-vegetate after new construction. Some suppliers of native plants are listed at

http://hbs.bishopmuseum.org/botany/riparian/pdf/propagators.pdf

Some plants have demonstrated their adaptation to the area by growing at the Kaloko Makai site naturally [marked with asterisk (*) in the list below]. Dryland adapted plants suitable for landscaping, many with beautiful foliage or flowers, are listed below. Comments on some of the plants follow.

Ground cover:

'Ilima	*Sida* sp. (prone) (*)
malapilo	*Capparis sandwichiana* (*)
nehe	*Melanthera integrifolia, Melanthera subcordata*
'ohai	*Sesbania tomentosa*
pā'ūohi'iaka	*Jacquemontia ovalifolia*
pili grass	*Heteropogon contortus* (*)
'ulei	*Osteomeles anthyllidifolia*

Shrub:

'a'ali'i	*Dodonaea* sp. (*)
'ākia	*Wikstroemia* sp.
'ilie'e	*Plumbago zeylanica*
'ilima	*Sida* sp. (upright) (*)
naio	*Myoporum sandwicense* (*)
pōhinahina	*Vitex rotundifolia*

Tree:

kou	*Cordia subcordata*
milo	*Thespesia pupulnea*
'ohe makai	*Reynoldsia sanwicensis* (*)
'ōhi'a lehua	*Metrosideros polymorpha* (*)
wiliwili	*Erythrina sandwicensis*

'A'ali'i / *Dodonaea* sp.

'A'ali'i (Figure 22) grows at roughly shrub height without hedge trimming. It produces flowers and foliage useful in lei making and is host to several invertebrates. It stays green year round without watering.

© Figure 22. 'A'ali'i *Dodonaea* sp. foliage and blossoms

'Ilima / *Sida* sp.

Figure 23. 'Ilima *Sida* sp.

'Ilima (Figure 23) is host to a large number of native invertebrates, maintains color and foliage during the dry months and needs little maintenance. It grows in a prone, ground cover form and an upright, shrub form. The plant will grow at seaside or inland locations.

Maiapilo / *Capparis sandwichiana*)

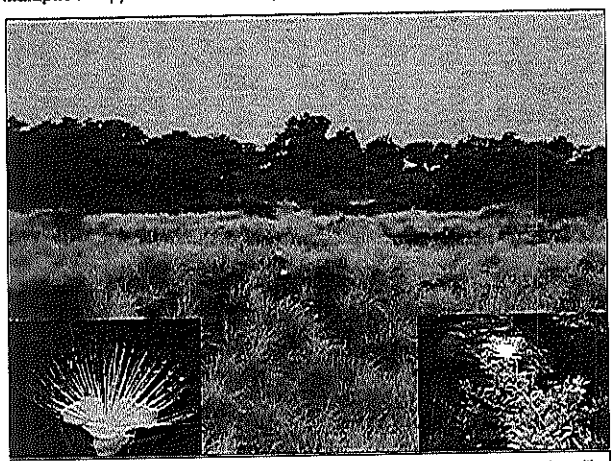
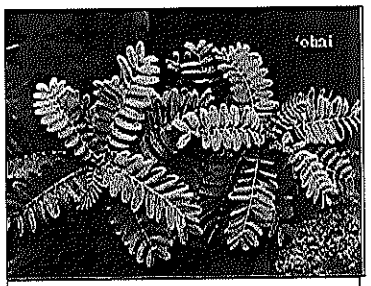


Figure 24. Maiapilo (*Capparis sandwichiana*) [center] blooming amidst native pili and alien fountain grasses.

Maiapilo (Figure 24), host to several native arthropods, is well adapted to the Kaloko Makai site. The plant bears numerous white flowers, which wilt to a beautiful pink as the day progresses. Already growing on site, maiapilo, planted as a ground cover, provides nectar, pollen, and keeps down weeds. Morning walkers and joggers would find them a special attraction.

'Ohai / *Sesbania tomentosa*

Once known from all major islands, 'Ohai (Figure 25) now is rare outside planted areas. It has beautiful, moisture retaining, silvery leaves and dark orange, curved blossoms. It is a short shrub and stays 'green' all summer.



© Figure 25. 'Ohai *Sesbania tomentosa*

'Ōhi'a lehua (*Metrosideros polymorpha'*)

'Ōhi'a lehua (Figure 26) can be a bush or tree and is well known for its attractive flowers much desired for lei making. It is now used more frequently in home landscaping on all islands. It could be planted in common areas at Kaloko Makai. In addition to the red flower, there are also other colors.

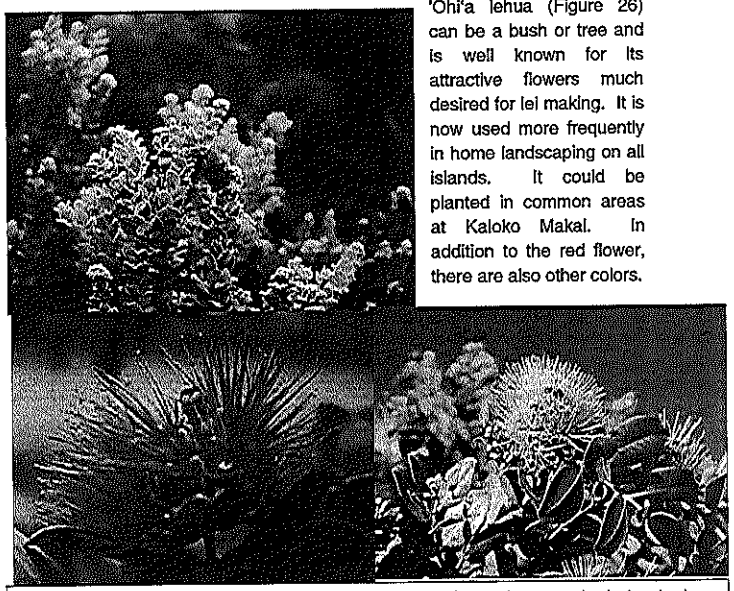
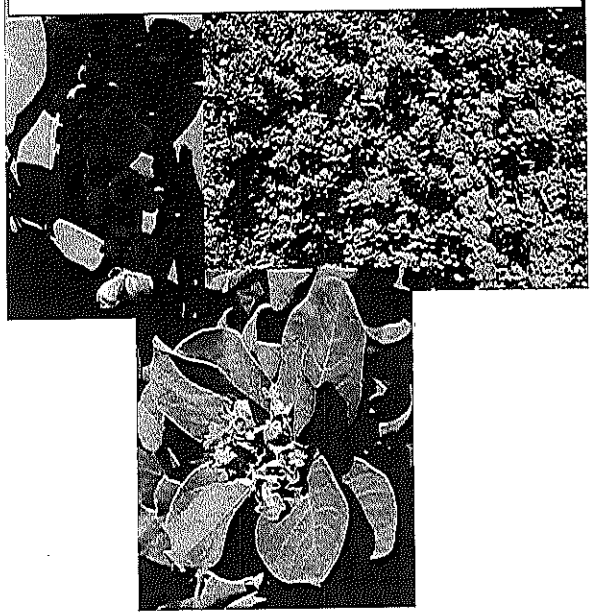


Figure 26. The species name of 'ōhi'a lehua, *polymorpha*, refers to the many physical and color varieties encompassed by the species.

'Ōhi'a is host to many native insects. As it provides a dependable nectar source for birds, the trees would make a reliable location for bird watching when in bloom.

Pōhinahina / beach vitex / *Vitex rotundifolia*
Now considered a beach plant (Figure 27), this hardy, flowering creeper likes to cascade over rocky areas or down small slopes but will form hedges. It will easily grow in upland locations. It tolerates abuse associated with human co-habitation, and even responds to pruning. It would form a natural hedge along pathways, thus keeping people on pathways with grace, beauty, and low upkeep. Spicy smelling leaves, small blue flowers, and brown seed capsules create visual interest. No watering required after establishment. Foliage, flowers, and seed capsules are all good lei making materials.



© Figure 27. Pōhinahina seed capsules, foliage, and flower

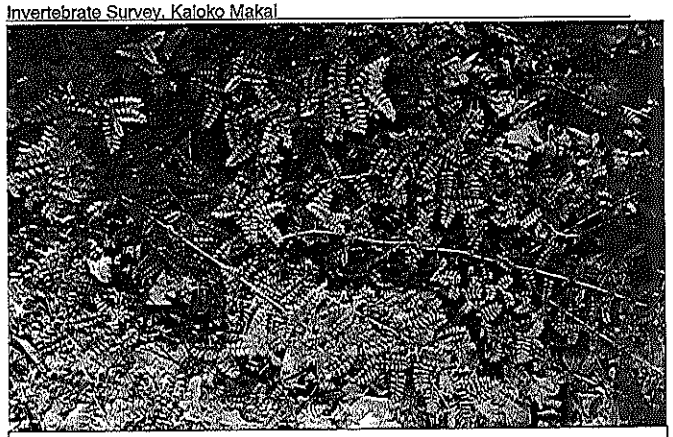
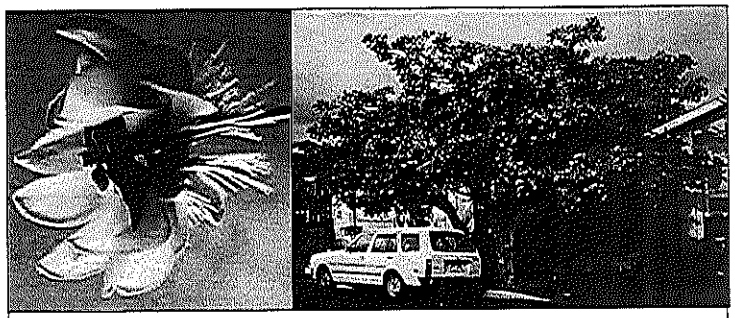


Figure 28. 'Ulei (*Osteomeles anthyllidifolia*)

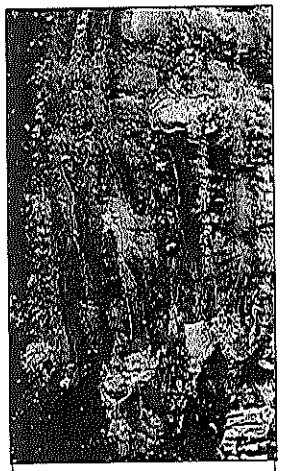
'Ulei *(Osteomeles anthyllidifolia)*
'Ulei is a low growing plant (Figure 28) making a good ground cover, sometimes combined with other plants. It will grow in open areas or semi-shade. It is slower growing than some plants.

wiliwili / *Erythrina sandwicensis*



© Figure 29. Wiliwili is dryland adapted and needs no watering

Wiliwili (Figure 29) has a proven track record as a dryland decorative, low maintenance planting, co-habiting with homes and parks. Seasonal flushes of flowers provide remarkable beauty. The seeds make beautiful lei.



© Figure 30. Wiliwili receives solar energy through green bark when leaves are dropped.

Although currently wiliwili is under attack from a recently introduced alien gall wasp, a control agent of that pest is expected soon. Wiliwili is summer deciduous - dropping its leaves in summer and relying on minimal photosynthesis through green bark (Figure 30). Native wiliwili have suffered less from the wasp's attacks than the alien *Erythrina* trees, in part because their green bark provides some nutrition during periods when leaves are reduced by the wasp's effect.

Community Education:
The best defense the fragile dry forest ecosystems can have is an informed public. Providing signage and partnering with community environmental groups to provide information and guidance about enjoying the preserved dry forest, archaeological, and natural features, would make preservation more effective. Providing defined pathways would reduce trampling of plants and disturbance of wildlife.

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Steven Lee Montgomery conducted all collecting and is responsible for all conclusions. Anita Manning contributed to preparation of this report. Some images used in this report were not taken in the course of this project. These photos, marked by © symbol were made by Anita Manning and/or S. L. Montgomery prior to this contract and were chosen because they best illustrate the subject.

STANDARD NOMENCLATURE
Bird names follow *Hawaii's Birds* (Hawaii Audubon Society 2005).
Invertebrate names follow
Freshwater & Terrestrial Mollusk Checklist (HBS 2002b)
Common Names of Insects & Related Organisms (HES 1990)
Hawaiian Terrestrial Arthropod Checklist (HBS2002a; Nishida 2002)
Mammal names follow *Mammals in Hawaii* (Tomich 1986).
Place name spelling follows *Place Names of Hawaii* (Pukui et al. 1976).
Plant names follow
Manual of the Flowering Plants of Hawaii (Wagner et al. 1999)
A Tropical Garden Flora (Staples and Herbst 2005)

ABBREVIATIONS

ASL	above mean sea level
DLNR	Department of Land and Natural Resources, State of Hawai'i
DOFAW	Division of Forestry and Wildlife, State of Hawai'i
FOIA	Freedom of Information Act Request
ft	feet
HBS	Hawai'i Biological Survey
m	meter
MV	Mercury Vapor
n.	new
sp.	species
spp.	more than one species
TMK	Tax Map Key
UH	University of Hawai'i
USFWS	United States Fish and Wildlife Service
UV	Ultraviolet

GLOSSARY[4]

Adventive: organisms introduced to an area but not purposefully.

Alien: occurring in the locality it occupies ONLY with human assistance, accidental or purposeful; not native. Both Polynesian introductions (e.g., coconut) and post-1778 introductions (e.g., guava, goats, and sheep) are aliens.

Arthropod: insects and related invertebrates (e.g., spiders) having an external skeleton and jointed legs.

Aspiration: invertebrates are transferred from the original location (leaf, net, etc.) into a large vial. Two tubes are lodged in one stopper in the vial. Air drawn in on one tube, creates suction at the end of the second tube; the target insect is drawn into the vial by the pulling air.

Endemic: naturally occurring, without human transport, ONLY in the locality occupied. Hawaii has a high percentage of endemic plants and animals, some in very small microenvironments.

Gibbous: describes the Moon or a planet before and after it is full, when it has more than half its disk illuminated; swollen on one side.

Indigenous: naturally occurring without human assistance in the locality it occupies; may also occur elsewhere, including outside the Hawaiian Islands. (e.g., Naupaka kahakai (*Scaevola sericea*) is the same plant in Hawai'i and throughout the Pacific).

Insects: arthropods with six legs, and bodies in 3 sections

Invertebrates: animals without backbones (insects, spiders, snails / slugs, shrimp)

Larva/larval: an immature stage of development in offspring of many types of animals.

Makai: toward the ocean

Mauka: toward the mountains

Midden: food refuse in an archaeological setting, often in a heap or pile

Mollusk: invertebrates in the phylum Mollusca. Common representatives are snails, slugs, mussels, clams, oysters, squids, and octopuses.

Morph: one form of a polymorphic (or many formed) population which despite their physical differences are part of the same genus or species.

Native: organism that originated in area where it lives without human assistance. May be indigenous or endemic.

Naturalized: an alien organism that, with time, yet without further human assisted releases or plantings, has become established in an area to which it is not native.

4 Glossary based largely on definitions in *Biological Science: An Ecological Approach*, 7th ed., Kendall/Hunt Publishing Co., Dubuque, a high school text; on the glossary in *Manual of Flowering Plants of Hawai'i*, Vol.2, Wagner, et al., 1999, Bishop Museum Press, and other sources.

Glossary: cont.

Nocturnal: active or most apparent at night.

Pupa: the stage between larva and adult in insects with complete metamorphosis, a non-feeding and inactive stage often inside a case

Purposefully introduced: an organism brought into an area for a specific purpose, for example, as a biological control agent.

Rare: threatened by extinction and low numbers.

Species: all individuals and populations of a particular type of organism, maintained by biological mechanisms that result in their breeding mostly with their kind.

Waning: describes a gradual decrease in the amount of the moon's disk that is visible; shrinking

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Appendix G

Survey of Avian and Terrestrial Mammalian Species
Rana Productions, Ltd.
September 2006

A Survey of Avian and Terrestrial Mammalian Species on TMK (3) 7-3-09:17, 25, 26, and 28, at Kaloko, and Kohanaiki, North Kona District, Island of Hawai'i.

DRAFT

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Introduction

This report summarizes the findings of avian and mammalian surveys conducted on an approximately 1,151-acre parcel of land identified as TMK (3) 7-3-09:17, 25, 26, and 28. The property is located in the Kaloko, and Kohanaiki *Ahupua'as*, in the North Kona District, Hawai'i (Figure 1).

The primary purpose of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either the federal or the State of Hawai'i's endangered species programs on, or within in the immediate vicinity of the site. Federal and State of Hawai'i listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2006). Fieldwork was conducted between September 7 and 11, 2006.

Avian phylogenetic order and nomenclature follows *The American Ornithologists' Union Check-list of North American Birds 7th Edition* (American Ornithologists' Union 1998), and the 42nd through the 47th supplements to *Check-list of North American Birds* (American Ornithologists' Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Higher native and naturalized plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner et al. and Wagner and Herbst, 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al. 1974).

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on Page 14.

General Site Description

The approximately 1,151-acre parcel of land is located in Kaloko, in the North Kona District. The site is transected by the existing Hina Lani Street, and is located immediately upslope (*mauka*) of the Kaloko Light Industrial Park. The site is bound to the northeast, east and south by undeveloped land. The northwest boundary of the site is along Queen Ka'ahumanu Highway, the southwest corner is bound by the Kaloko Light Industrial Park, and the northwest by the Kohanaiki Industrial Park (Figure 1). The site gently slopes from east to west from a maximum elevation of ~ 740-feet above mean sea level (ASL) at the northeastern boundary, down to ~ 60-feet ASL at the northwestern boundary, located along Queen Ka'ahumanu Highway (USGS 1996). The project area consists to three distinct lava flows, the oldest is an 'a'ā flow disgorged from Mount Hualālai between 5,000 and 10,000 years ago, most of this flow has been covered by a mix of weathered broken pāhoehoe, and 'a'ā flows deposited some 3,000 to 5,000 years ago, much of this flow has since been covered by newer flows laid down between 1,500

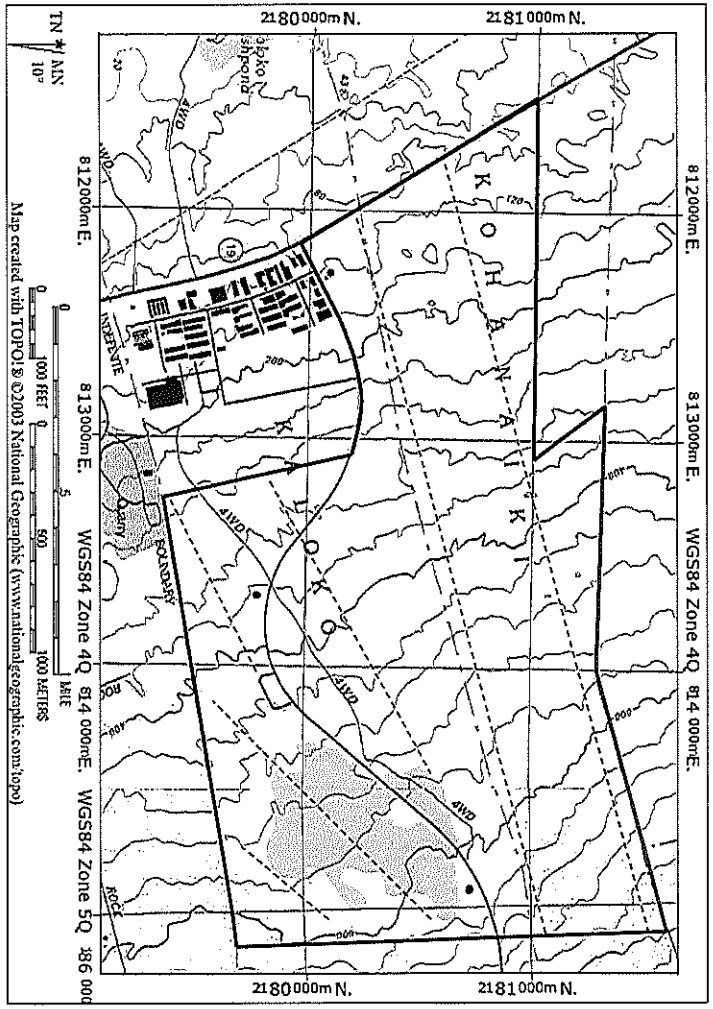
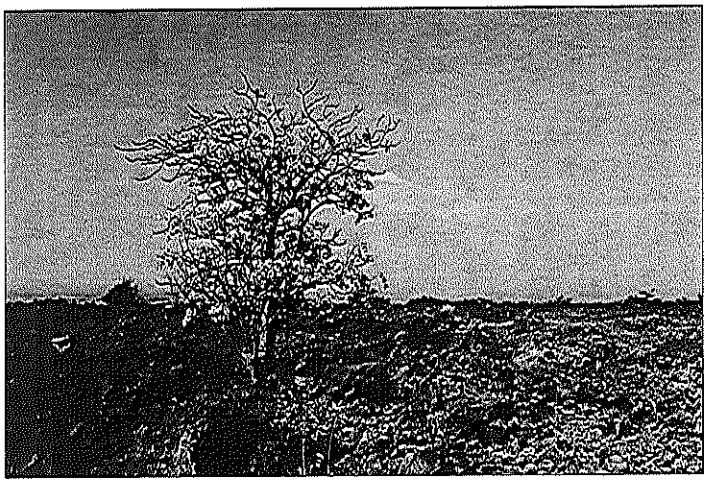


Figure 1 – Kaloko Properties Study Site
Red Line Represents Approximate Boundaries of the Site – Blue Dotted Lines Indicate Avian Transects

and 3,000 years ago (Wolfe and Morris 1996, USGS 1996).

The vegetation present on the oldest 'a'ā flows not covered by newer flows has a high degree of native components remaining, including several rare and endangered species (Figure 2). The bulk of the site, however, is dominated by alien vegetation. This dominant vegetation can be best characterized as a Fountain Grass/ Koa Haole Grassland subtype of a Lowland Dry Grassland Community as described in Gagne and Cuddihy (1990) (Figure 3).

Figure 2
Dryland Forest Vegetation on 'A'ā Flows,
***'ohe makai* (*Reynoldsia sandwicensis*) in the foreground**



Avian Survey Methods

Thirty-two avian count stations were sited at approximately 300-meter intervals along six linear transects running from east-to-west through the project area (Figure 1). One six-minute point count was conducted at each station. Field observations were made using Leitz 10 X 42 binoculars to sight birds and by listening for vocalizations. Counts took place between 06:30 a.m. and 10:30 a.m., the peak of daily bird activity. In an attempt to detect nocturnally flying seabirds over-flying the project area. An additional two hours were spent within the project area on the evenings of September 7th, 8th and 9th on the

mornings of September 8th, 9th, and 10th, 2006. Time not spent counting was used to search the study site for species and habitats that were not detected during count sessions.

Figure 3
Typical Fountain Grass/ Koa Haole Grasslands

Avian Survey Results

A total of 881 individual birds of 20 different species, representing 11 separate families were recorded during station counts. Additionally, one other species, Barn Owl (*Tyto alba*) was recorded as an incidental observation on the evening of September 7, 2006. One of the species recorded, Pacific Golden-Plover (*Pluvialis fulva*) is an indigenous migratory shorebird species that nests in the high Arctic, returning to Hawaii and the Tropical Pacific to spend the fall and winter months each year. The remaining 18 species detected are considered to be alien to the Hawaiian Islands, with one of them, Red Junglefowl (*Gallus gallus*) a domestic species, not currently considered to be established in the wild on the Island of Hawai'i (Table 1).

No avian species currently listed as endangered, threatened, or proposed for listing under either the federal or the State of Hawai'i's endangered species programs were detected during the course of this survey.

Avian diversity and densities were relatively low, though in keeping with the extremely dry habitat present on the site. Three species, House Finch (*Carpodacus mexicanus*), Zebra Dove (*Geopelia striata*), and Japanese White-eye (*Zosterops japonicus*), accounted for 43% of the total number of individual birds recorded. House Finchs were the most frequently recorded species, accounting for slightly more than 17% of the total number of individual birds recorded during station counts. An average of 27 birds were recorded per station count.

Table 1

Avian Species Detected Within the Kaloko Properties Study Site

Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	0.84
Black Francolin	*Francolinus francolinus*	A	0.56
Erckel's Francolin	*Francolinus erckelii*	A	0.06
Red Junglefowl	*Gallus gallus*	D	0.06
Kalij Pheasant	*Lophura leucomelanos*	A	0.09
	CHARADRIIFORMES		
	CHARADRIIDAE - Lapwings & Plovers		
	Charadriinae - Plovers		
Pacific Golden-Plover	*Pluvialis fulva*	IM	0.34
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	2.22
Zebra Dove	*Geopelia striata*	A	3.66
	STRIGIFORMES		
	TYTONIDAE - Barn Owls		
Barn Owl	*Tyto alba*	A	I-1
	PASSERIFORMES		
	ZOSTEROPIDAE - White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	3.44
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	A	0.22
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	2.25
	EMBERIZIDAE - Emberizids		
Saffron Finch	*Sicalis flaveola*	A	1.31

Common Name	*Scientific Name*	*ST*	*RA*
Yellow-billed Cardinal	*Paroaria capitata*	A	0.88
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	1.56
	FRINGILLIDAE - Fringilline and Carduleline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	4.75
Yellow-fronted Canary	*Serinus mozambicus*	A	1.31
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*	A	0.66
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
African Silverbill	*Lonchura cantans*	A	2.03
Nutmeg Mannikin	*Lonchura punctulata*	A	0.66
Java Sparrow	*Padda oryzivora*	A	1.13

KEY TO TABLE 1

ST Status

A Alien – Introduced to the Hawaiian Islands by humans

D Domestic Species – Not considered to be established in the wild on the Island of Hawai'i

IM Indigenous Migratory Species

RA Relative Abundance – Number of birds detected divided by the number of count stations (32)

I- Incidental – Species detected incidentally, followed by the number of individuals recorded

Mammalian Survey Methods

All observations of mammalian species were of an incidental nature. With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of Hawai'i are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed and heard within the study area. Visual and electronic scans, using a Broadband AnaBat II® ultrasonic bat detector, were made for bats during crepuscular periods on the evening of September 7, 8 and 9, 2006.

Mammalian Survey Results

A total of nine mammalian species were detected while on the site. Seven European house mice (*Mus musculus domesticus*) were seen within the study area (Table 1). A total of five small Indian mongooses (*Herpestes a. auropunctatus*) were seen at various locations within the study site, as were two cat (*Felis catus*), one pig (*Sus s. scrofa*) and 35+ goats (*Capra h. hircus*). Additionally, skeletal remains were encountered of small

Indian mongoose, cat, pig, cattle (*Bos Taurus*), goat and sheep (*Ovis aries*). Tracks and sign of dogs (*Canis f. familiaris*), was encountered in several locations within the study area.

Hawai'i's sole endemic terrestrial mammalian species, the endangered Hawaiian hoary bat, was not detected during the survey, though I did record one bat as an incidental observation on the evening of September 15, 2006, while driving up Hina Lani Street. All of the alien mammalian species recorded during this survey are deleterious to avian and floristic components of the remaining native ecosystems present on the Island.

Table 2

Mammalian Species Detected Within the Kaloko Properties Study Site

Common name	*Scientific name*	Status
	CHIROPTERA - BATS	
	VESPERTILIONIDAE - Common Bats	
Hawaiian hoary bat	*Lasiurus cinereus semotus*	EE
	RODENTIA - GNAWERS	
	Muridae - Old World Rats & Mice	
European house mouse	*Mus musculus domesticus*	A
	CARNIVORA- FLESH EATERS	
	Canidae - Wolves, Jackals & Allies	
Domestic dog	*Canis f. familiaris*	A
	Viverridae - Civets & Allies	
Small Indian mongoose	*Herpestes a. auropunctatus*	A
	Felidae- Cats	
House cat	*Felis catus*	A
	ATRIODACTYLA - EVEN-TOED UNGULATES	
	Suicidae - Old World Swine	
Pig	*Sus s. scrofa*	A
	Bovidae- Hollow-horned Ruminants	
Domestic cattle	*Bos taurus*	A
Domestic goat	*Capra h. hircus*	A
Domestic sheep	*Ovis aries*	A

KEY TO TABLE 2

A Alien – Introduced to the Hawaiian Islands by humans

EE Endangered Endemic – Native and unique to the Hawaiian Islands

Discussion

Avian Resources

Avian diversity and densities detected during this survey were in keeping with the results of at least one previous survey conducted on a portion of this site (David 1995), and with several other surveys conducted on lands immediately adjacent to it (David 2000a, 2000c, 2004a, 2004c) and with several other surveys conducted on various parcels of land, with like habitat, in the lowland areas in the North Kona District within the recent past (David 1999, 2000b, 2000d, 2001, 2003, 2004b, 2005b, 2005c, 2006a, 2006b).

All but one of the 21 avian species detected during the course of this survey are considered to be alien to the Hawaiian Islands. The lone native species detected, Pacific Golden-Plover is a common indigenous migratory shorebird species, seen throughout the state between July and late April each year. Avian diversity and densities were low, as is to be expected given the fountain grass dominated xeric habitat present on the site and the surrounding property.

Although not detected during this survey it is possible that small numbers of the endangered endemic Hawaiian Petrel (*Pterodroma sandwichensis*), or *ua'u*, and the threatened Newell's Shearwater (*Puffinus auricularis newelli*), or *'a'o*, over-fly the project area between the months of May and November (Banko 1980a, 1980b, Day et al. 2003a, Harrison 1990).

Hawaiian Petrels were formerly common on the Island of Hawai'i (Wilson and Evans 1890–1899). This pelagic seabird reportedly nested in large numbers on the slopes of Mauna Loa and in the saddle area between Mauna Loa and Mauna Kea (Henshaw 1902), as well as at the mid to high elevations of Mount Hualālai. It has, within recent historic times, been reduced to relict breeding colonies located at high elevations on Mauna Loa and, possibly, Mount Hualālai (Banko 1980a, Banko et al. 2001, Cooper and David 1995, Cooper et al. 1995, Day et al. 2003, Harrison 1990, Hue et al. 2001, Simons and Hodges 1998).

Newell's Shearwaters were formerly common on the Island of Hawai'i (Wilson and Evans 1890–1899). This species breeds on Kaua'i, Hawai'i and Moloka'i in extremely small numbers. Newell's Shearwater populations have dropped precipitously since the 1880s (Banko 1980b, Day et al., 2003b). This pelagic species nests high in the mountains in burrows excavated under thick vegetation, especially *uluhe* (*Dicranopteris linearis*) fern.

The primary cause of mortality in both Hawaiian Petrels and Newell's Shearwaters is thought to be predation by alien mammalian species at the nesting colonies (U.S. Fish & Wildlife Service 1983, Simons and Hodges 1998, Ainley et al. 2001). Collision with man-made structures is considered to be the second most significant cause of mortality of these seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on

their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds often collide with manmade structures, and if they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals (Hadley 1961, Telfer 1979, Sincock 1981, Reed et al. 1985, Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998, Ainley et al. 2001). There is no suitable nesting habitat within or close to the proposed project site for either of these pelagic seabird species.

Mammalian Resources

The findings of the mammalian survey are consistent with the results of at least one previous survey conducted on a portion of this site (David 1995), and with several other surveys conducted on lands immediately adjacent to it (David 2000a, 2000c, 2004a, 2004c) and with several other surveys conducted on various parcels of land, with like habitat, in the lowland areas in the North Kona District within the recent past (David 1999, 2000b, 2000d, 2001, 2003, 2004b, 2005b, 2005c, 2006a, 2006b).

One Hawaiian hoary bats was detected as an incidental observation flying down-slope, (*makai*), from above the eastern boundary of the site towards the ocean. This finding was not unexpected as bats are regularly seen *mauka* of the project site and also below the subject property in the Kaloko-Honokōhau National Historical Park and above the Honolōhau small boat harbor on a seasonal basis (Jacobs 1994, David 2006c). Unlike nocturnally flying seabirds, which often collide with man-made structures, bats are uniquely adapted to avoid collision with most obstacles, man-made or natural. They navigate and locate their prey primarily by using ultrasonic echolocation, which is sensitive enough to allow them to locate and capture small volant insects at night.

Very little research into the life cycle, distribution, or population estimates of this species, has been conducted; and much of what has been studied, were small, disconnected, or anecdotal studies as opposed to coherent controlled experiments. Fundamental research into this species distribution and life cycle has just begun (Bonaccorso et al. 2005).

Although only European house mice were detected during the course of this survey it is probable that the other three established *muridae* known from the Island of Hawai'i, roof rat (*Rattus r. rattus*), Norway rat (*Rattus norvegicus*), and possibly Polynesian rat (*Rattus exulans hawaiiensi*) use resources within the subject property at least occasionally. Especially since the site is bound to the north and south by light industrial developments that likely harbor these commensal species.

Potential Impacts to Protected Species

Hawaiian Hoary Bat

As previously discussed, it is likely that Hawaiian hoary bats over-fly the general project area on a seasonal basis. The planting of trees and ornamental vegetation following

development may increase the presence of prey items for this insectivorous bat, and thus may in fact enhance foraging resources for this species in the area.

Hawaiian Petrel and Newell's Shearwater

The principal potential impact that the development of this site poses to Hawaiian Petrels and Newell's Shearwaters is the increased threat that birds will be downed after becoming disoriented by external lights associated with the new development.

Endangered Waterbirds

Although there is no standing water, streams or other water features on the property, and thus the habitat present does not support waterbirds, two listed waterbird species Hawaiian Coot (*Fulica alai*), and the Hawaiian endemic sub-species of the cosmopolitan Black-necked Stilt (*Himantopus mexicanus knudseni*), are resident breeding species within the Kaloko-Honokōhau National Historical Park, which is located directly across the Queen Ka'ahumanu Highway from the northwestern terminus of the project site. The development of this site does not pose direct threats to these species or their habitat, although, the potential exists that the development could pose secondary threats to the National Park and to it's endangered birds if noxious substances such a petroleum, oils lubricants, sewage and the like were to migrate downslope (*makai*) from the project into the Park.

Conclusions

The modification of the current habitat on the site is not expected to result in significant impacts to any avian or mammalian species currently listed as threatened, endangered or proposed for listing under either the Federal, or State of Hawai'i endangered species programs. Furthermore, the development of the site is not expected to have a significant deleterious impact on native faunal resources found within the North Kona District, with the one possible caveat that if noxious substances such a petroleum, oils lubricants, sewage and the like were to migrate downslope, from the project either during construction, or following build-out, into the Kaloko-Honokōhau National Historical Park, the possibility exists that such an event could result in deleterious impacts to two listed waterbird species, Hawaiian Coot and Black-necked Stilt and/or their habitat.

Recommendations

- To reduce the potential for interactions between nocturnally flying Hawaiian Petrels and Newell's Shearwaters with external lights and man-made structures, it is recommended that any external lighting that may be required in conjunction with development of the project be shielded (Reed et al. 1985, Telfer et al. 1987). This mitigation would serve the dual purpose of minimizing the threat of disorientation and downing of Hawaiian Petrels and Newell's Shearwaters, while at the same time complying with the Hawaii County Code § 14 – 50 *et seq.* which requires the shielding of exterior lights so as to lower the ambient glare caused by unshielded lighting to the astronomical observatories located on Mauna Kea.

- To address potential runoff issues and possible secondary impacts to listed waterbird species and their habitat found within the Kaloko-Honokōhau National Historical Park, it is recommended that once a conceptual Master Plan has been developed that the project, consult with both the USFWS and the National Park Service to ensure that implementation of the Master Plan will not result in deleterious impacts to listed waterbird species and their habitat, which is present within the Park.

Glossary:

'A'ā – Clinker lava formed by slow moving lava flows.
Alien - Introduced to Hawai'i by humans.
Ahupua'a – Traditional Hawaiian land division, usually extending from the uplands to the sea.
Commensal – Animals that share humans' food and lodgings, such as rats and mice.
Crepuscular – Twilight hours.
Diurnal – Daytime
Domesticated – Feral species, not considered established in the wild on the Island of Hawai'i.
Endangered – Listed and protected under the ESA as an endangered species.
Endemic – Native and unique to the Hawaiian Islands.
Indigenous - Native to the Hawaiian Islands, but also found elsewhere naturally.
Muridae – Rodents, including rats, mice and voles, one of the most diverse families of mammals.
Mauka – Upslope, towards the mountains
Makai – Down-slope, towards the ocean.
Nocturnal – Nighttime, after dark.
Pāhoehoe – Sheet lava formed by relatively fast moving lava flows.
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Threatened - Listed and protected under the ESA as a threatened species.
Volant – Flying, capable of flight - as in flying insect.
Xeric – Extremely dry conditions or habitat.

ASL – Above mean sea level.
DLNR – Hawaii State Department of Land & Natural resources.
ESA – Endangered species act of 1973, as amended.
TMK – Tax Map Key.
USFWS – U.S. Fish & Wildlife Service

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Appendix H

Biological Survey for Portable Water Well Site and Access Road at Kaloko Heights
Rana Biological Consulting Inc.
July 2011

Biological Surveys Conducted for a Potable Water well and Access Road, Kaloko Heights, North Kona District, Island of Hawai'i

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Introduction and Background

Stanford Carr Development is proposing to develop a potable water well and an access road on an approximately 3.5-acre site within their Kaloko Heights planned community, located in Kaloko, North Kona, Island of Hawai'i (Figure1).

This report describes the methods used, and the results of biological surveys conducted on the site as part of the environmental disclosure process associated with the proposed project. The primary purpose of the surveys was to determine if there are any botanical, avian or mammalian species currently listed, or proposed for listing under either federal or State of Hawai'i endangered species statutes within or adjacent to study site.

The federal and State of Hawai'i listed species status follows species identified in the following referenced documents, Department of Land and Natural Resources (DLNR) 1998; U. S. Fish & Wildlife Service (USFWS 2005a, 2005b, 2011). Fieldwork was conducted on June 16 and 17, 2011.

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text.

General Project and Site Descriptions

The approximately 3.5-acre site is an approximately 460-meter by 30-meter wide corridor (Figure 1). The site slopes gently from north to south slopes from a maximum elevation of ~ 315 meters above mean sea level (MSL), down to ~ 305 meters MSL. The terrain is composed of a mix of *'a'ā* and *pāhoehoe* lava flows disgorged from Hualālai during the Holocene age. Lava flows on the site were laid down between 1,500 and 3,000 years ago. (Wolfe and Morris 1996).

The vegetation present on the site is dominated almost to the exclusion of native species by alien grasses, weedy species, ornamental and fruit trees. The bulk of this habitat is covered with an almost impenetrable under story of Guinea grass (*Panicum maximum*), *kiawe* (*Prosopis pallida*), *koa haole* (*Leucaena leucocephala*), silk oak (*Grevillea robusta*) and an assortment of *kukui* (*Aleurites moluccana*), African tulip (*Spathodea campanulata*), mango (*Mangifera indica*), Guava (*Psidium sp.*), and papaya (*Carica papaya*) trees. Shrubs include lantana (*Lantana camara*), Christmas berry (*Schinus terebinthefolius*), and sourbush (*Pluchea symphytifolia*) (Figure 2). The only native species recorded was *uhaloa* (*Waltheria indica*), a common ruderal species.

Hina Lani Drive binds the site to the north, to the east the site is bound by a residential subdivision, and to the south and west by undeveloped lands (Figure 1). There are a remarkable number of pig (*Sus s. scrofa*) trails running throughout the study site.

Figure 1 - Study area

Figure 2 – Typical vegetation within the study corridor showing Guinea grass, *koa haole* and Christmas berry

Methods

Plant names follow *Manual of the Flowering Plants of Hawai'i* (Wagner *et al.*, 1990, 1999) for native and naturalized flowering plants, Palmer (2003) for ferns, and *A Tropical Garden Flora* (Staples and Herbst, 2005) for crop and ornamental plants. Place names follow *Place Names of Hawaii* (Pukui *et al.*, 1974). The avian phylogenetic order and nomenclature used in this report follows the *AOU Check-List of North American Birds* (American Ornithologists' Union, 1998), and the 42nd through the 51st supplements to the Check-List (American Ornithologists' Union, 2000; Banks et al., 2002, 2003, 2004, 2005, 2006, 2007, 2008; Chesser *et al.*, 2009, 2010). Mammal scientific names follow (Tomich, 1986).

Botanical Survey Methods

The reconnaissance level botanical survey was undertaken on July 15, 2011 utilizing wandering transects that traversed the study corridor. Although this survey was conducted in the dry season, significant amounts of rainfall had fallen across North Kona over the

previous several months, maintaining the vegetation in a healthy state. Plants, including annuals, were readily observable and identifiable.

Avian Survey Methods

The avian surveys were conducted on July 15, 2011. Four avian count stations were sited equidistantly from each other along the length of the study corridor. A single 8-minute avian point count was made at each of the count stations. Field observations were made with the aid of Leica 10 X 42 binoculars and by listening for vocalizations. The counts and subsequent searches of the site, was conducted between 6:30 am and 10:00 am in the morning. Time not spent counting the point count stations was used to search the remainder of the site for species and habitats not detected during the point counts. Weather conditions were ideal, with no rain, and winds of between 1 and 4 kilometers an hour during point count periods.

Mammalian Survey Methods

With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *'ōpe'ape'a* as it is known locally, all terrestrial mammals currently found on the Island of Hawai'i are alien species, and most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all terrestrial vertebrate mammalian species detected within the site. The mammalian survey was conducted concurrently with the avian survey on July 15, 2011.

Results

Avian Survey

A total of 110 individual birds of 10 species, representing eight separate families, were recorded during the station counts (Table 1). One species detected, Chicken (Red Junglefowl) [*Gallus gallus*] is a domesticated species that is not established in the wild on the Island of Hawai'i. All 10 avian species recorded during the course of this survey are considered to be alien to the Hawaiian Islands.

No avian species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs were detected during the course of this survey (DLNR, 1998; USFWS, 2005a, 2005b, 2011).

Avian diversity and densities were in keeping with the location of the site and the habitat present on it. Two species, Japanese White-eye (*Zosterops japonicus*), and Red-billed Leothrix (*Leiothrix lutea*), accounted for slightly more than 57 percent of all birds recorded during the station counts.

Table 1 – Avian Species Detected Within the Kaloko 7 Site			
Common Name	*Scientific Name*	*ST*	*RA*
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Red Junglefowl	*Gallus gallus*	D	0.75
Kalij Pheasant	*Lophura leucomelanos*		0.50
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	0.75
Zebra Dove	*Geopelia striata*	A	4.00
	PASSERIFORMES		
	ZOSTEROPIDAE - White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	9.25
	TIMALIIDAE - Babblers		
Red-billed Leiothrix	*Leiothrix lutea*		6.50
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	1.00
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	1.50
	FRINGILLIDAE - Fringilline and Carduleline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	0.75
	ESTRILDIDAE - Estrildid Finches		
Java Sparrow	*Padda oryzivora*	A	2.50

Key to table 1

ST Status

D Domesticated species – not considered to be established in the wild on the Island of Hawai'i

A Alien – Introduced to the Hawaiian Islands by humans

RA Relative Abundance - Number of birds detected divided by the number of count stations (4)

Mammalian Survey

Three terrestrial mammalian species were detected during the course of this survey. A total of ten pigs were seen, and a remarkable number of very well travelled pig trails, beds and rooting sites were present throughout the small site. Several dogs (*Canis f. familiaris*) were heard barking from within the subdivision abutting the site to the north. Additionally one small Indian mongoose (*Herpestes a. auropunctatus*) was seen between Hina Lani Street and the vegetation on the site.

No mammalian species currently protected or proposed for protection under either the federal or State of Hawai'i endangered species programs were detected during the course of this survey (DLNR, 1998; USFWS; 2005a, 2005b, 2011).

Discussion

Botanical Resources

The site is dominated almost to the complete exclusion by alien species, chief among these are Guinea grass, *koa haole* and Christmas berry. The vegetation is extremely dense. Without the numerous pig trails present throughout the site it would require cutting transects to access the interior of the site. No rare or protected native species were recorded, nor are any to be expected given the vegetation and pig densities on the site.

Avian Resources

The findings of the avian survey are consistent with the location of the site, and the habitat present on it. All of the avian species recorded during the course of this survey are alien to the Hawaiian Islands. The findings of this survey are also consistent with the results of at least one other avian survey conducted on lands immediately adjacent to this site (David, 2004)

Although no seabirds were detected during this survey, it is probable that both the endangered Hawaiian Petrel (*Pterodroma sandwichensis*), and the threatened endemic sub-species of the Newell's Shearwater (*Puffinus auricularis newelli*), over-fly the project area in small numbers between April and the middle of December each year. Both species have been recorded flying to and from their nesting colonies over the greater Kona area (Day et al., 2003; David 2011). Both of these pelagic seabird species nest high in the mountains in burrows excavated under thick vegetation, especially *uluhe* (*Dicranopteris linearis*) fern. There is no suitable nesting habitat for either of these seabird species on, or close to the project site.

The primary cause of mortality in the two aforementioned seabird species is thought to be predation by alien mammalian species at the nesting colonies (USFWS 1983; Simons and Hodges 1998; Ainley *et al.*, 2001). Collision with man-made structures is considered to be the second most significant cause of mortality of these seabird species in Hawai'i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds often collide with manmade structures, and if they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals (Hadley 1961; Telfer 1979; Sincock 1981; Reed *et al.*, 1985; Telfer *et al.*, 1987; Cooper and Day, 1998; Podolsky *et al.* 1998; Ainley *et al.*, 2001; Hue *et al.*, 2001; Day *et al* 2003).

Mammalian Resources

The findings of the mammalian survey are consistent with the location of site and the habitat currently present on it. The findings of this survey are also consistent with the results of at least one other mammalian survey conducted on lands immediately adjacent to this site (David, 2004)

Although no rodents were detected during the course of this survey, it is likely that the four established alien *muridae* found on Hawai'i, roof rat (*Rattus r. rattus*), Norway rat (*Rattus norvegicus*), European house mouse (*Mus musculus domesticus*) and possibly Polynesian rats (*Rattus exulans hawaiiensis*) use various resources found within the site on a seasonal basis. All of these introduced rodents are deleterious to native ecosystems and the native faunal species dependant on them.

No Hawaiian hoary bats were detected during the course of this survey. Hawaiian hoary bats are widely distributed along the Kona coast and are present in most areas that still have tree and dense shrubs, (USFWS, 1998; Bonaccorso et al., 2005, 2007; 2011; David, 2011). It is probable that this species forages for insects over the site on a seasonal basis, and it is possible, though rather unlikely that bats may roost on the site occasionally.

Potential Impacts to Protected Species

Botanical

It is not expected that the modification of the vegetation on this site will result in deleterious impacts to any rare, or listed native plant species.

Seabirds

The principal potential impact that construction and operation of the proposed well and access road poses to protected seabirds is the increased threat that birds will be downed after becoming disoriented by lights associated with the project during the nesting season. The two main areas that outdoor lighting could pose a threat to these nocturnally flying seabirds is if, 1) during construction it is deemed expedient, or necessary to conduct nighttime construction activities, 2) following build-out, the potential operation of streetlights and security lighting during the seabird nesting season.

Hawaiian hoary bat

The principal potential impact that the development and operation of the proposed well and access road poses to bats is during the clearing and grubbing phases of construction as vegetation is removed. The removal of vegetation within the project site may temporarily displace individual bats, which may use the vegetation as a roosting location. As bats use multiple roosts within their home territories, the potential disturbance resulting from the removal of the vegetation is likely to be minimal. During the pupping season female carrying their pups may be less able to rapidly vacate a roost site as the vegetation is cleared, additionally adult female bats sometimes leave their pups in the roost tree while

they themselves forage, very small pups may be unable to flee a tree that is being felled. Potential adverse effects from such disturbance can be avoided or minimized by not clearing woody vegetation taller than 4.6 meters (15-feet), between June 15 and September 15, the period in which bats are potentially at risk from vegetation clearing.

Recommendations

If nighttime construction activity or equipment maintenance is proposed during the construction phases of the project, all associated lights should be shielded, and when large flood/work lights are used, they should be placed on poles that are high enough to allow the lights to be pointed directly at the ground.

Following build-out it is recommended that any streetlights or facility security lighting that may be required for public safety reasons be shielded (Reed et al. 1985, Telfer et al. 1987). This minimization measure would serve the dual purpose of minimizing the threat of disorientation and downing of Hawaiian Petrels and Newell's Shearwaters, while at the same time complying with the Hawai'i County Code § 14 – 50 *et seq.* which requires the shielding of exterior lights so as to lower the ambient glare caused by unshielded lighting to the astronomical observatories located on Mauna Kea.

It is recommended that to minimize potential impacts to roosting Hawaiian hoary bats, woody vegetation taller than 4.6 meters (15-feet) high not be cleared between June 15 and September 15 on that site.

It is recommended that, where appropriate and practicable, native plant species be used in landscaping efforts. Not only is this ecologically prudent, but also if the appropriate plants are used, it will also likely save maintenance and water costs over the long term.

Critical Habitat

There is no federally delineated Critical Habitat present on or adjacent to the site. Thus the development and operation of the proposed well and access road will not result in impacts to federally designated Critical Habitat. There is no equivalent statute under State law.

Glossary

Alien – Introduced to Hawai'i by humans
Endangered – Listed and protected under the Endangered Species Act of 1973, as amended (ESA) as an endangered species
Indigenous – Native to the Hawaiian Islands, but also found elsewhere naturally
Makai – Down-slope, towards the ocean
Mauka – Upslope, towards the mountains
Muridae – Rodents, including rats, mice and voles, one of the most diverse family of mammals
Nocturnal – Nighttime, after dark.
'Ōpe'ape'a – Endemic endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*)
Pelagic – An animal that spends its life at sea – in this case seabirds that only return to land to nest and rear their young
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles
Sign – Biological term referring tracks, scat, rubbing, odor, marks, nests, and other signs created by animals by which their presence may be detected
Threatened – Listed and protected under the ESA as a threatened species

DLNR – Department of Land and Natural resources
DOFAW – Division of Forestry and Wildlife
ESA – Endangered Species Act of 1973, as amended
USFWS – United State Fish & Wildlife Service

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Appendix I

Survey of Terrestrial Invertebrate Resources at Kaloko Makai

Steven Lee Montgomery, Ph.D.

November 2008

Survey of Terrestrial Invertebrate Resources at Kaloko Makai, Kaloko and Kohanaiki, North Kona, Hawai'i Island

DRAFT

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Submitted to:
Wilson Okamoto Corporation
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Stanford Carr Development, LLC

For:
SCD Kaloko Makai, LLC

November 15, 2008

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SUMMARY
The Kaloko Makai project site sampled in this biological survey yielded native and adventive arthropods. No invertebrate currently listed as endangered or threatened under either federal or state statutes was located within the survey area.

INTRODUCTION
This report summarizes the findings of an invertebrate[1] survey conducted in support of an environmental impact statement as part of a proposal to construct residential units, areas for retail and commercial use, and supporting infrastructure in North Kona, Hawai'i. SCD Kaloko Makai, LLC, proposes to build on 1,142 acres / 462.2 hectares (h.) of land, within portions of Tax Map Keys: (3) 7-3-009: 017, 025, 026, and 028. This survey was conducted by Steven L. Montgomery, Ph. D., for SCD Kaloko Makai, LLC, as part of a team effort directed by Wilson Okamoto Corporation and Stanford Carr Development, LLC

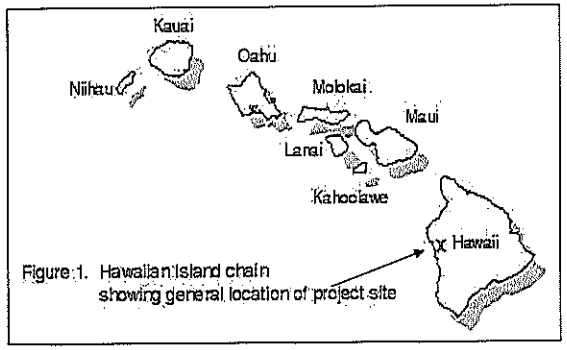


Figure 1. Hawaiian Island chain showing general location of project site

Invertebrates are often the dominant fauna in natural Hawaiian environments. The primary emphasis of this survey was on terrestrial arthropods, particularly those that are endemic or indigenous species, especially those having legal status under either, or both federal and state endangered - threatened species statutes (DLNR 1996, 1997, USFWS 2005a, 2007, 2008).

[1] Animals without backbones: Insects, shrimp, snails, spiders, etc.

Native Hawaiian plant, vertebrate, and invertebrate populations are interdependent. Certain insects are obligatorily attached to host plants and use only that plant as their food. The health of native Hawaiian invertebrate populations depends on habitat quality and absence or low levels of continental predators. Sufficient food sources, host plant availability, and the absence or low levels of introduced, continental predators and parasites comprise a classic native, healthy ecosystem. Consequently, where appropriate in the survey discussion, host plants and some introduced arthropods are also noted.

GENERAL SITE DESCRIPTION
The project area is on the leeward coast of the Island of Hawai'i (Figure 1) in the Kaloko and Kohanaiki ahupua'a, North Kona district. The property is approximately one mile mauka of the coastline, between 100 +/- feet (ft.) above sea level (ASL) / 30.5 meters (m.) at the western end to 740 ft. ASL / 213.4 m. at the eastern end. It is bounded by Queen Kaahumanu Highway to the northwest. The makai portion of the property is framed by Kaloko Light Industrial Park, Kohanaiki Industrial Park, and Queen Kaahumanu Highway. The largest part of the property is bisected by Hina Lani Street. (Figure 4).

Figure 2. Typical area of koa haole (*Leucaena leucocephala*) and fountain grass (*Pennisetum setaceum*)

Geologically, the site is mostly pāhoehoe and 'a'ā lavas with lava tubes present throughout the area. Much of the surface is uneven and irregular. The site incorporates several vegetation communities, from a nearly intact lowland dry forest to scrub dominated by koa haole (*Leucaena leucocephala*) or by Christmas berry (*Schinus terebinthifolius*) (Figure 2). Biologically the most interesting area is the "open to closed native forest occurring on the relatively recent lava flow comprising most of the central portion of the southern half of the study area" (Figure 3) (Whistler 2006). The area was recognized as Management Unit 10 in the US Fish & Wildlife Service's *Recovery Plan for the Big Island Plant Cluster* (1998). This dry forest area has supported several native Hawaiian plants of interest as hosts or shelter for native invertebrates.

Figure 3. Typical native dry forest area on 'a'ā lava flow.

The larger site has been through a variety of changes as first Polynesians then Europeans adapted the area to their own needs. Early Hawaiian cultivation of crops, water collection in lava tubes, and establishment of housing began the process of change. Historic grazing of domesticated and feral animals, and more recent bulldozing (Bell et al. 2008a, b, c; Esh 2008) all combined to replace large portions of the native vegetation - and native invertebrate population - with a succession of introduced plants and animals (Whistler 2006; David 2006). The bird and mammal survey found evidence of 20th century host plant damaging goats, sheep, and pigs in the area (David 2006).

There are no natural year-round surface sources of fresh water that would support specialized invertebrates. Some of the lava tubes were used into the historic period for collection of dripping fresh water (Bell et al. 2008a, b, c; Esh 2008).

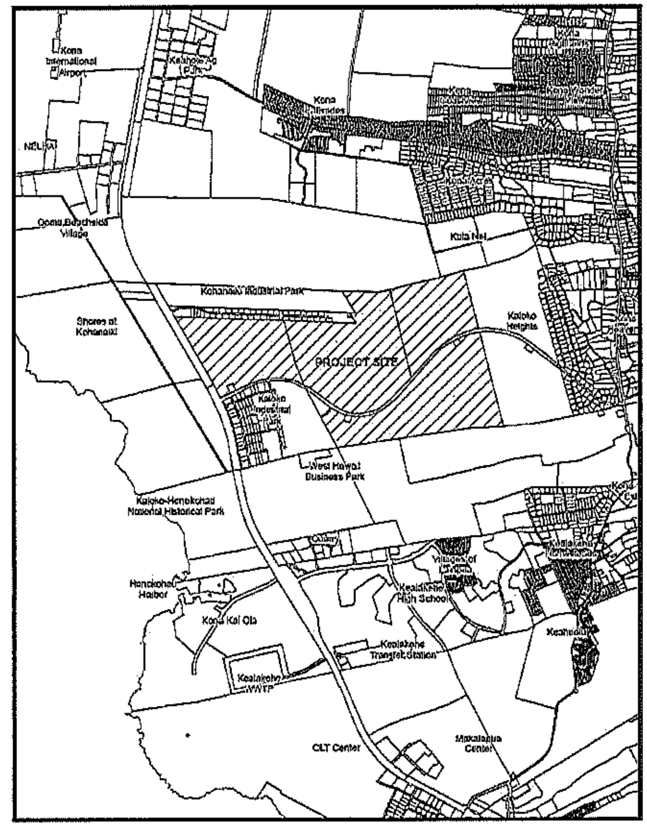


Figure 4. Map showing North Kona, Hawai'i, location of project site.

[from Wilson Okamoto 2007, Figure 1-4]

INVERTEBRATE SURVEY METHODS

Since 1970, I have taken part in field projects at other locations in the Kailua-Kona area and in other dryland locations throughout the island chain. Surveys of other dryland areas have created a sizeable body of information on native invertebrate and related botanical resources found in areas similar to Kaloko Makai (Bridwell 1920, Swezey 1935). Those experiences and the results of those surveys provided the basis for my study design and my analysis of results.

Previous Surveys and Literature Search

Botanical surveys of the project area have been conducted since at least 1983 (Nagata 1983). A previous Environmental Impact Statement associated with this site (Kimura 1996) was reviewed. Recent avian, mammalian (David 2006), and botanical surveys (Whistler 2006) also were very helpful in preparing for this study. None of the previous studies referenced terrestrial invertebrate surveys or surveys of lava tubes for cave-adapted invertebrate species.

Recent archaeological studies (Bell et al. 2008a, b, c; Esh et al. 2008) showed evidence of extensive lava tubes in the project area, but no mention of cave-adapted invertebrate species.

Searches were made in the Bishop Museum Library, University of Hawai'i Hamilton Library, and State's Office of Environmental Quality Control web site (2008). Surveys done for other projects in the general area were reviewed (Char 1986, 1990, Geometrician 2003; Helber et al. 1986, 1991a, 1991b; PBR 1991, 2007, 2008; Towill 1976, 1988; Wilson Okamoto 2000). Only the planning for Kula Nei, a nearby mauka project, included a survey of lava tube invertebrates (Howarth 2006, SWCA 2006-7).

A search was made for independent studies of invertebrates associated with this site or with nearby sites. Online proprietary data bases of such as AGRIS, Biological Abstracts, Ingenta Connect, and Zoological Record also were searched. Searches were made for publicly available articles mounted on the web (Goggle Scholar) and in regional and national databases which provide geographic access, such as the Pacific Basin Information Node and Hawaii Natural Heritage Program. Data base searches were made in Bishop Museum's Arthropod Checklist, and the University of Hawaii, Hamilton Library's Hawaii-Pacific Journal Index. Access to the project area was limited prior to construction of Queen Ka'ahumanu Highway. The bulldozing of a jeep road by Huehue Ranch in 1955 gave access to part of the property, but travel was mostly through the subject area to reach ocean resources (Bell et al. 2008a). The area lacked

the commercial agriculture which generated much of Hawaii's formal entomological surveys since the 1900s. The combination of these factors makes it unremarkable that this review showed no previous independent invertebrate surveys of the area.

The US Fish & Wildlife Service has demonstrated an interest in the native dry forest area of the property for many years. Since 1995 USFWS personnel have surveyed the property at least once (USFWS 1997). As a part of our literature search a Freedom of Information Act Request (FOIA) was initiated with USFWS regarding those surveys and records were obtained. Unfortunately, detailed cave by cave records were not found. The information resulting from the FOIA request is incorporated in several places in this report.

Fieldwork

Field surveys were conducted in September and October 2008. I conducted a general assessment of terrain and habitats at the start of the survey. Surveying efforts were conducted at various times of day and night, a technique which is vital for a thorough survey. Native botanical resources identified by Nagata (1983), Whistler (2006), and US Fish & Wildlife Service records (see "Previous Surveys and Literature Search" above) were an important focus of my searches, as were lava tubes located by the archaeological survey (Bell et al. 2008a, b, c; Esh et al. 2008).

Fieldwork schedule:

September 12-15, 2008	Site examination, orientation, collecting; light survey
September 28-30, 2008	
October 1-4, 2008	General collecting; light survey; lava tubes surveys
October 7, 2008	Lava tube orientation; general collecting; light survey
October 8-10, 2008	General collecting; light survey; lava tubes surveys

Daylight surveying was concentrated during the cooler early morning and late afternoon hours when temperatures are lower and invertebrates would be more active.

See Figure 7 for light surveying locations within the survey area.

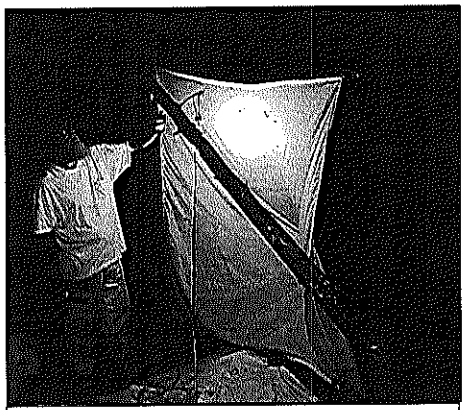
Collecting Methods

The following collecting methods for terrestrial invertebrates were used as appropriate to the terrain, botanical resources, and target species.

Baiting: Baits are used to attract insect species to specific tastes or smells. For example, some flies come to dead or dying plants with a specific odor. Baits can mimic that smell and taste and so attract those insects. Insects are enticed by the bait's 'advertisement.' Baits are placed at likely locations or inserted in bottle traps and checked periodically. Any insects at the bait are then observed and collected if appropriate. This is much more efficient than roaming the research area seeking cryptic insects. Baiting is a recognized method of censusing lava tubes for cave adapted fauna.

Lava tubes were chosen for baiting from among tubes located in my own work and in the previous archaeological surveys. In choosing lava tubes for baiting I excluded from my survey all lava tubes which archaeological surveying had shown contained human remains and those chosen for preservation. Also excluded were tubes with multiple skylights or a short dark zone. Tubes were chosen for baiting based on the size of the dark zone, presence and amount of intruding roots, and dampness which experience shows create a lava tube environment suitable for cave fauna. Traps used shrimp paste and blue cheese baits, both proven and durable attractants in other lava tube surveys. Baited traps were placed in 3 lava tubes October 10 and retrieved on October 13, 2008.

Host plant searches: Potential host plants, both native and introduced, were searched for arthropods that feed or rest on plants. Wandering transects were followed throughout the inland area with emphasis on reaching native host plants.



© Figure 5. A light census is important to understand the invertebrate fauna.

Light sampling: A survey of insects active at night is vital to a complete record of the fauna. Many insects are only active at night to evade birds, avoid desiccation

and high temperatures, or to use night food sources, such as night opening flowers. Light sampling uses a bright light source in front of a white cloth sheet (Figure 5). Night active insects seem to mistake the collecting light for the light of the moon, which they use to orient themselves. In attempting to navigate by the collecting light, confused insects are drawn toward the light and land on the cloth in confusion. This type of collecting is most successful during the dark phase of the moon or under clouds blocking starlight. Most moths and other night fliers are not capable of very distant flight. Consequently, light sampling does not call in many insects from outside the survey area.

Sampling was conducted for approximately 11 hours on each night of surveying. The light source was a mercury vapor (MV) bulb. An additional, UV light source was used at all sites. Every effort was made to diminish competing light from

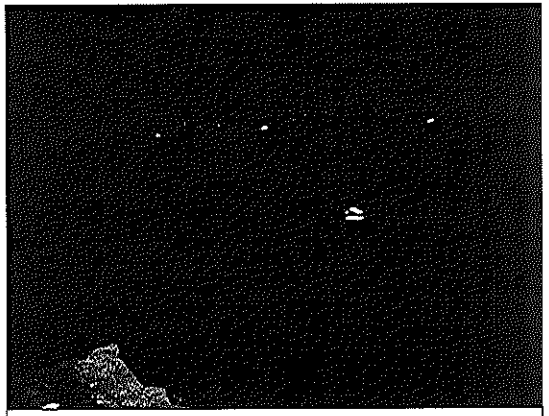


Figure 6. Monitoring locations [blue light] were located away from competing light sources [background] to the extent possible.

housing, street lights and other artificial sources (Figure 6), but these were a factor in response success at some locations.

Locations were chosen based on experience, host plant proximity, and terrain. The botanical survey placed most of the native plants in the dry land forest area. As the interconnection of arthropods and host plants would predict, light sampling in that area yielded the most native arthropods. All light sample locations are marked on Figure 7.

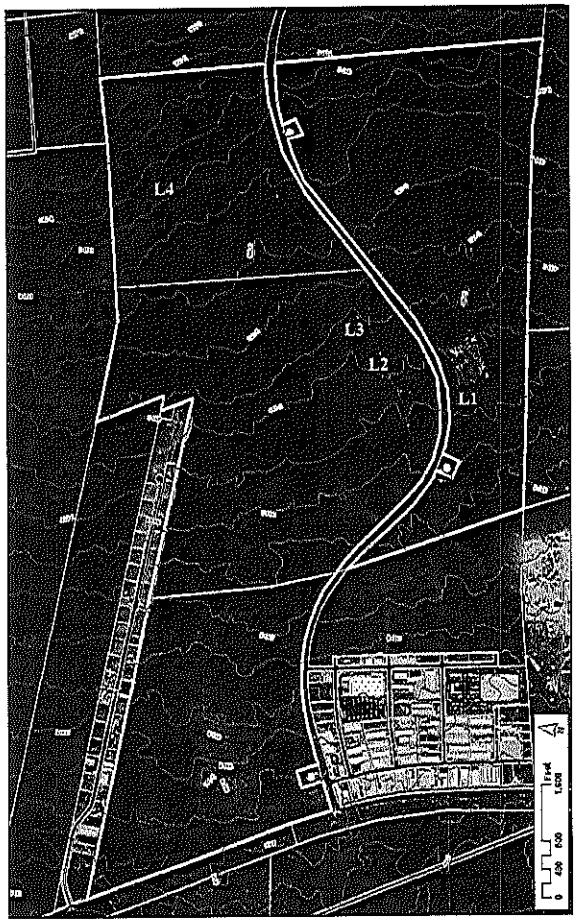


Figure 7. Map of Kaloko Makai project area showing light monitoring sites, lava tube.

L = light monitoring = lava tube

Sweep nets: This is a most common and general method of collecting most flying and perching insects. A fine mesh net was swept across plants, leaf litter, rocks, etc. to collect any flying, perching, or crawling insects. Transfer from the net was either by aspiration, or by placing the net contents into a holding container.

Visual observation: At all times, I was vigilant for any visual evidence of arthropod presence or activity. Visual observations provide valuable evidence and are a cross check that extends the reach of sampling techniques. Visual observation also included turning over rocks, examining dead wood, and other debris.

Survey Limitations / Conditions
My ability to form advisory opinions is influenced in the following ways:

Collecting conditions:

Weather: Weather was favorable for surveying during each field day. The atmospheric vog did not appear to alter the behavior of invertebrates.

Seasons: Monitoring at a different time of the year might produce a longer or different arthropod list. Weather and seasonal vegetation play an especially important role in any survey of invertebrates. Many arthropods time their emergence and breeding to overlap or follow seasonal weather or to coincide with growth spurts of an important plant food. Host plant presence/absence, and seasonal changes, especially plant growth after heavy rains, affect the species collected.

Although there were some small rains in the weeks prior to this survey, true winter rains and vegetation revitalization had not taken place. If vegetation had developed after winter rains, a different insect list might have resulted. Nevertheless, the low level of native plants outside the dry forest zone was a stronger factor in determining the invertebrates encountered than the season or condition of vegetation.

Moon: The moon presented competition to the collecting light on the evenings of September 12-13-14, 2008. The moon rose between 4 and 5 p.m. each night[2] and set between 3 and 4 a.m. the following morning. The moon was described as "waning gibbous" with 85-90% of the Moon illuminated. (USNO) The relative lack of artificial light sources at the chosen sites compensated to a degree for the competition.

The moon did not present any competition to light collecting efforts September 28-October 2, and relatively little on October 3 and 4. At the start of fieldwork, the moon rose during daylight hours and then set before dark. At the end of fieldwork the moon was setting in the early evening 8:00-830 p.m., continuing to provide many moon-free hours for light surveying (USNO) During the short period the moon was 'up,' it presented small competition to my bright light in the largely unlit parcels under study.

Limited duration: Surveying for a longer period of time might enlarge the list of species; however, I believe the survey provides a fair review of the invertebrates present.

Selectivity: My survey was focused on finding any endemic and indigenous Hawaiian land invertebrates species. No attempt was made to collect or completely document the many common alien arthropod species present.

The exclusion of lava tubes based on cultural content and human remains did limit the choice of tubes. A thorough review of color photographs of lava tube interiors and faunal remain listings provided in the archaeological reports (Bell et al. 2008a, b, c; Esh et al. 2008) allowed a useful review of some aspects of the lava tube setting in the excluded tubes (see Lava Tube Species page 20).

RESULTS:

Incidental records:

In addition to the invertebrate results noted below, rats were present as shown by their destruction of kukui seeds (*Aleurites moluccana).* The small Indian mongoose (*Herpestes auropunctatus*) was seen at various locations on the property.

[2] Times given are for Kailua-Kona as closest city tracked by U. S. Naval Observatory

DISCUSSION

Native species of note are discussed. Also, information is provided on adventive species often misidentified by the public, especially those confused with native species. Non-native species in conflict with native species or human beings are discussed.

INVERTEBRATE RESOURCES

ARTHROPODS

CRUSTACEA

DECAPODA (Shrimps, Lobsters, Crabs, Crayfish)

Undetermined species

Parts of three individual crabs (Figure 8) were seen in one lava tube. The examples observed in the lava tube did not appear to be part of any midden. Photographs of the specimens are under review by specialists to determine the species. Further information will be provided as it becomes available.

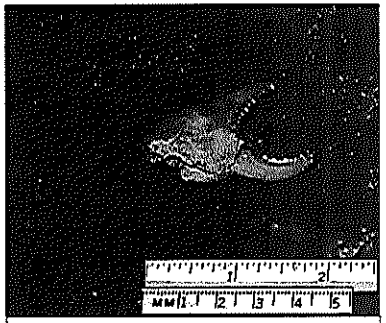


Figure 8. Crab remains seen in several tubes.

ARANEAE (spiders)

Dysderidae: *Dysdera crocota* C L Koch, 1838

This small spider (10-14 mm), known to bite humans, was seen on the floor of a lava tube.

Salticidae: Unidentified species

One immature jumping spider was noted under stones on the inland lava flow. Identification of immatures from one sample is extremely difficult. There are 9 spiders of the family Salticidae reported from Hawai'i Island, four endemics, all of the genus *Sandalodes*, and 5 adventive or introduced spiders. (HBS 2002a, Nishida 2002)

Scytodidae: *Scytodes* sp. or spitting spider
There are three adventive species known on Hawai'i Island: *S. fusca*, *S. longipes*, and *S. stiatipes*. This genus gets its common name from the hunting method of spitting strands of silk from its fangs to fasten down prey for easy dining. (Mascord 1970)

INSECTA
HETEROPTERA (True bugs)
Lygaeidae: *Nysius* sp.
This native seed bug, commonly found in dryland locations, uses many alien and native host plants. It is known from most islands in the Hawaiian chain.

LEPIDOPTERA (butterflies, moths)

Cosmopterigidae: *Hyposmocoma* sp.
Two species of *Hyposmocoma*, as caterpillars, were found in the rocky habitat (Figure 9) and three species, in adult stage (Figure 11), came to light. Considering the population is likely at a low level due to the dry weather, the diversity is noteworthy. In the wet season it could be expected that a higher number of individuals and more species would be recovered. *Hyposmocoma* are called "case bearers" because after an early beginning inside a leaf curl or similar hiding place, the caterpillars create protection in an intricately constructed portable "cave" woven of their own silk. For camouflage, they add bits of their surroundings to the case using silk: snips of dry grass or leaves, flakes of bark, a little dirt (Figure 10). The case is then easily mistaken by a predator as

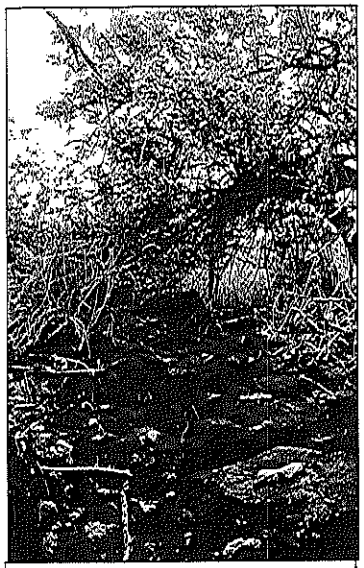
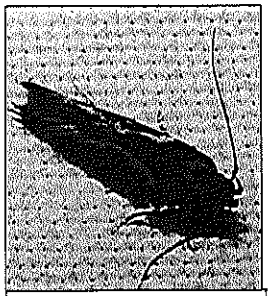


Figure 9. *Hyposmocoma* casebearers were found by lifting up slabs of broken pahoehoe.

another part of the inedible landscape. These bunkers are fitted with a hinged lid (operculum), pulled shut by tiny mandibles to defend them from enemies. Their relationship to the case is similar to that of a hermit crab to his shell. They are dependent on their case, and die if removed – even if protected from predators and given food. They don't move far, but feed while partly emerged from the case, dragging along protective armor by their six true legs. Cases are sometimes attached to rocks or tree trunks and foliage. (Manning/Montgomery in Liittschwager & Middleton 2001)

Figure 10. *Hyposmocoma* caterpillars sheltered under rocks. Far left, a pseudoscorpion shared the habitat.



© Figure 11. *Hyposmocoma* sp.
Photo# starr-030724-0089
credit: "Forest & Kim Starr" (HEAR)

With over 500 kinds, *Hyposmocoma* micromoths are the greatest assemblage of Hawaiian island moths, showing astonishing diversity. After writing 630 pages on them, Dr. Elwood Zimmerman lamented the inadequacy of his study. He noted an enormous cluster of species with explosive speciation and diverging radiation (Zimmerman 1978). Much remains to be learned about the life ways of this interesting group of insects now under study by University of Hawaii's Dr. Daniel Rubinoff and his students (Rubinoff & Haines 2006).

Crambidae (grass moths)

Tamsica hyacinthina (Meyrick 1899)

This was the most common native species found during the survey. The caterpillars feed on a wide variety of grasses, allowing them to adapt to the changing flora at Kaloko. The genus was described by E. C. Zimmerman as "a cluster of poorly understood, obscure, difficult little species." (1958) Pioneering biologist R. C. L. Perkins noted "They are able to flourish in the driest localities near the coast...." (Perkins 1913).

Gracillariidae:
Caloptilia mabaella (Swezey), 1910 or *Caloptilia azaleella* (Brants), 1913

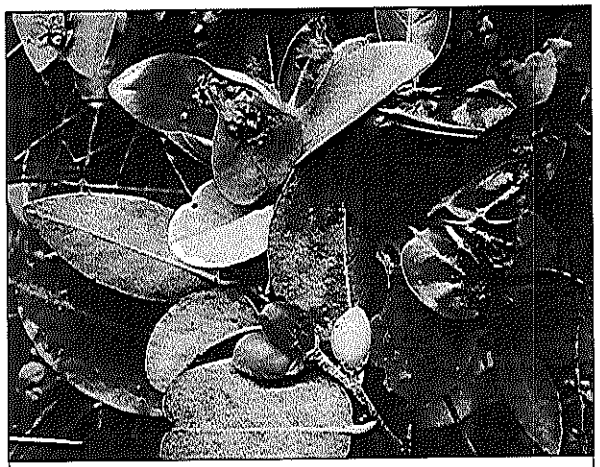
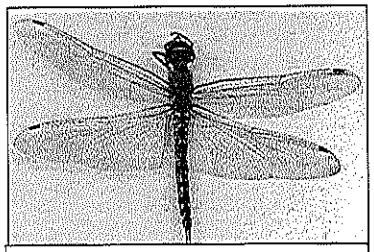


Figure 12. Lama (*Diospyros sandwicensis*) or Hawaiian persimmon at Kaloko dry forest showing damage by leaf miner *Caloptilia* sp.

The young and terminal leaves of lama trees (*Diospyros sandwicensis* or Hawaiian persimmon) in the dry forest area at Kaloko Makai show distinctive feeding damage associated with leaf miner caterpillars (Figure 12). Leaf miners burrow or "mine" inside a leaf, creating scars or bumps on the leaf surface where they have eaten out the inner flesh of the leaf. The most likely adventive pest is *Caloptilia* sp. *C. mabaella*, which has been known in the islands since 1910 (Swezey 1910, 1954), is previously recorded only from O'ahu. *Caloptilia azaleella* is known from O'ahu and Hawai'i Island, but not previously associated with *Diospyros sandwicensis*. (HBS 2002a; HOSTS 2008; Nishida 2002)

Noctuidae: *Schrankia* sp.
This small moth was previously noted in the lava tubes of Kaloko by US Fish & Wildlife Service personnel (USFWS 1997) and was found by this survey as well. The genus is very complex. As noted by Dr. F. G. Howarth (2006): "There are often 2 or 3 morphs in each cave that show different degrees of cave adaptation..."

ODONATA (Dragonflies and Damselflies)
Libellulidae: *Pantala flavescens* Globe skimmer



© Figure 13. Globe skimmers often use human created water sources

This indigenous dragonfly (Figure 13) was observed on the property. Among the most easily observed native insects, they are large, easily approached by people, and graceful in flight. Any small amount of fresh water will attract them and they often colonized human maintained water sources such as golf-course water hazards and stock tanks. Globe skimmers are widely distributed throughout the Hawaiian Islands, from Kure to Hawai'i Island (HBS 2002a, Nishida 2002) and have even been found flying at sea (Howarth & Mull 1992).

ORTHOPTERA (Praying Mantis, Grasshoppers, Crickets)
Gryllidae
Gryllodes sigillatus (Walker), 1869 Flightless field cricket
This world-wide traveler was first recorded in the Hawaiian Islands in 1895 (Zimmerman 1948). In the years since, it spread up and down the island chain.

Although superficially similar in appearance, *Gryllodes sigillatus* males can 'sing' by rubbing vestigial wings together, while the native species, *C. anahulu* (see page 25), is mute.

Table 1: List of Invertebrates:[3] Kaloko Makai, North Kona, Hawai'i

Species	Common Name	Status	Abundance	Notes
ARTHROPODA				
ARACHNIDA				
ARANEAE	spiders			
Dysderidae				
Dysdera crocota C L Koch, 1838		Adv	U	in lava tube
Heteropodidae				
Heteropoda venatoria	large brown spider cane spider	Adv	U	leaf litter
Salticidae	jumping spider			
unidentified immature		?	U	under stones
Scytodidae				
Scytodes sp.	spitting spider	Adv		in lava tube
PSEUDOSCROPIONIDA	pseudoscropions			
unidentified species 1		?		sheltering with casebearers
SCORPIONES	scorpions			
Buthidae				
Isometrus maculatus (De Geer)	lessor brown scorpion	Adv	U	in lava tube
CRUSTACEA				
DECAPODA	Shrimps, Lobsters, Crabs, Crayfish			
Coenobitidae:	Crab			
Coenobita sp.				
INSECTA				
BLATTODEA				
Blattidae	cockroaches			
Periplaneta americana(Linnaeus), 1758:	American cockroach	Adv	C	in lava tubes
COLLEMBOLA	springtails			
Entomobryidae				
undetermined sp. 1		?	R	under stones
HETEROPTERA	true bugs			
Lygaeidae	seed bugs			
Nysius sp.		End	O	at light
HOMOPTERA	planthoppers			
Cixiidae				
Oliarus sp.		End	R	*Reynoldsia* bark

[3] Names authority: Hawaii Biological Survey 2002a; Nishida 2002; Zimmerman 1948-80; Zimmerman 2001

Table 1: continued

Species	Common name	Status	Abundance	Notes
HYMENOPTERA	wasps, bees, ants			
Apidae				
Ceratina smaragdula (Fabricius)	small carpenter bee	Adv	U	at *Sophora*
Formicidae	ants			
Camponotus variegatus	carpenter ant	Adv	C	to light
Pheidole megacephala (Fabricius, 1793)	big-headed ant	Adv	C	on soil
Anoplolepis gracilipes (F. Smith, 1857)	longlegged ant	Adv	C	on soil
Vespidae	wasps			
Polistes exclamans Viereck, 1906	common paper wasp	Adv	C	at flowers
LEPIDOPTERA				
Cosmopterigidae	case bearers			
Hyposmocoma sp. 1	slender wedge case	End	R	under stones
Hyposmocoma sp. 2	broad case	End	U	under stones
Hyposmocoma sp. 3	black, pointed adult	End	A	at light
Crambidae (Pyralidae)	micro-moths			
Mestolobes sp.		End		at light
Orthomecyna sp.		End		at light
Tamsica hyacinthina (Meyrick 1899)		End	A	at light
Noctuidae				
Schrankia		End	O	in lava tube
Oiethreutidae				
Cydia latifemoris (Walsingham, 1907)		End	O	reared from *Sophora* seeds
Plutellidae				
Plutella nohoilo Robinson & Sattler, 2001		End	R	at light
Plutella xylostella (Linnaeus, 1758)		Adv	C	at light
Xyloryctidae				
Thyrocopa abusa Walsingham, 1907		End	R	in leaf litter, twigs uhluhi
ODONATA	dragonflies; damselflies			
Libellulidae	skimmers			
Pantala flavescens (Fabricius, 1798)	globe skimmer	Ind	C	in flight

Table 1: continued

Species	Common name	Status	Abundance	Notes
ORTHOPTERA	praying mantis, grasshoppers, crickets			
Gryllidae	crickets			
Gryllodes sigillatus (Walker)1869	flightless field cricket	Adv	A	on lava
CHILOPODA				
SCOLOPENDROMORPHA				
Scolopendridae	centipedes			
Scolopendra subspinipes Leach, 1815	large centipede	Adv	U	on soil

Status:
End endemic to Hawaiian Islands
Ind indigenous to Hawaiian Islands
Adv adventive
Pur purposefully introduced
? unknown

ABUNDANCE = occurrence ratings:
R Rare seen in only one or perhaps two locations.
U Uncommon- seen at most in several locations
O Occasional seen with some regularity
C Common observed numerous times during the survey
A Abundant found in large numbers
AA Very abundant abundant and dominant

Lava Tube Species

The lava tube survey yielded a few native invertebrates, with *Schrankia* sp. a moth, being the most common native species encountered. The most common arthropod encountered in the small sample of lava tubes surveyed was the adventive *Periplaneta americana* (American cockroach). These results are not surprising given that many of the lava tubes have skylights creating a short dark zone, or none at all (Figure 14). Some tubes lack covering vegetation. In many tubes there is no root system reaching into the lava tubes, and insufficient moisture to support a richer ecosystem. Other tubes have only a few grass roots (Figure 16). The major food source, long roots, (Figure 15) supporting most lava tube arthropod communities, is mostly absent.

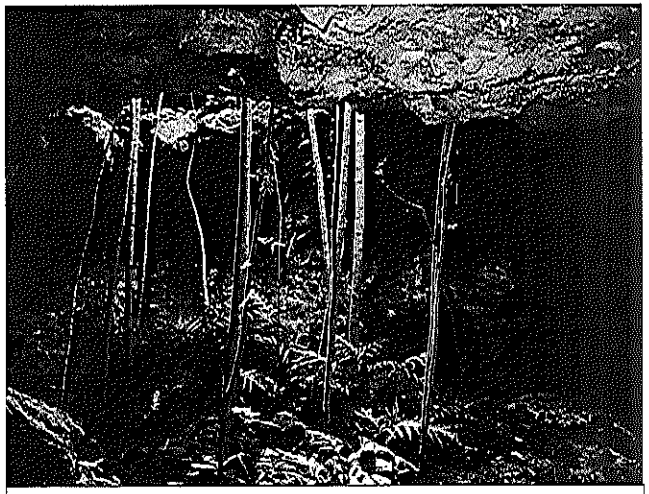


Figure 14. Skylights or openings to the outside, common in the Kaloko tube system, make many of the tubes too dry and too bright for a healthy dark-adapted cave ecosystem.

My examination of a small sample of lava tubes was augmented by a thorough review of color photographs taken inside numerous tubes and of faunal remains listings provided in the archaeological reports (Bell et al. 2008a, b, c; Esh et al. 2008). The images in those reports with very few exceptions show the lava tubes surveyed by archaeologists displaying no descending roots, or short roots.

In wetter lava tubes at other locations, large portions of the wall surface may be covered with a slime, on which the larvae of crane flies (*Limonia* sp.) leave characteristic trails. My review of the small patches in my sample caves (Figure 17) and of the color photographs in the archaeological reports (Bell et al. 2008a, b, c; Esh et al. 2008) shows no evidence of the baseball-stitch pattern (Figure 18) left by the feeding of the larvae of crane flies (*Limonia* sp.). Factors affecting the suitability of a habitat for *Limonia* include low humidity and apparent reduced nutritional content in the coating (Howarth 1973). Kaloko Makai tubes present both low moisture and few overhead plants with descending roots.

My findings seem to parallel those from a 1995 US Fish & Wildlife Service visit to some of the tubes. Fish & Wildlife representatives entered 25-30 caves as part of a survey of the property's dry forest area. US Fish & Wildlife Service reported most caves lacked aspects recognized as necessary to support cave-adapted ecosystems. Moisture levels were low and root penetration into the lava tube system was lacking. Although 6 caves looked more promising, only one species of *Shrankia* moth was seen in those caves. (USFW1997)

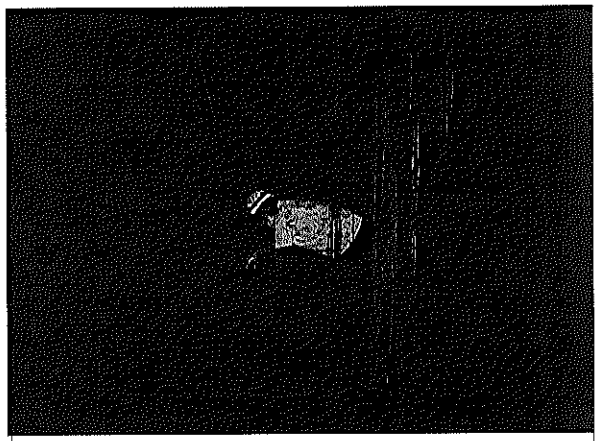


Figure 15. To support a thriving lava tube ecosystem a typical cavern (above) needs a large number of long and healthy roots penetrating from overhead vegetation.

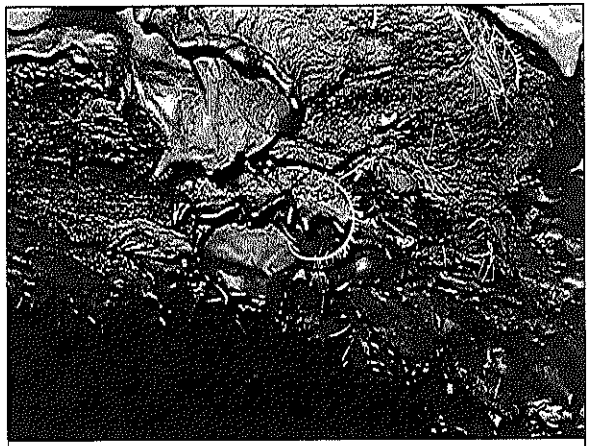


Figure 16. Typical view of short roots penetrating Kaloko Makai lava tubes.

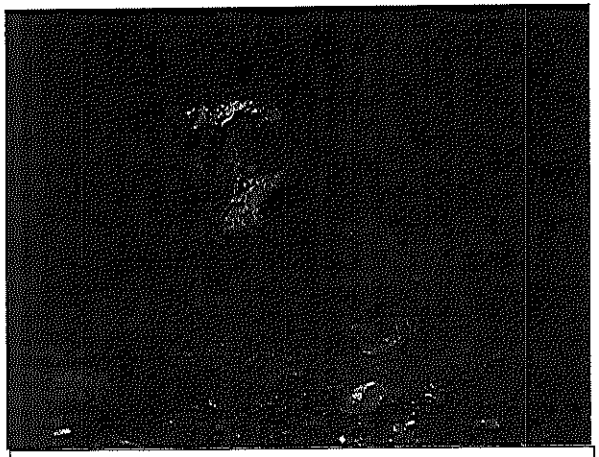


Figure 17. Typical view inside Kaloko lava tube. Slime coverings (white patches) were sporadic and showed none of the patterns created by feeding endemic crane fly larvae (example below).

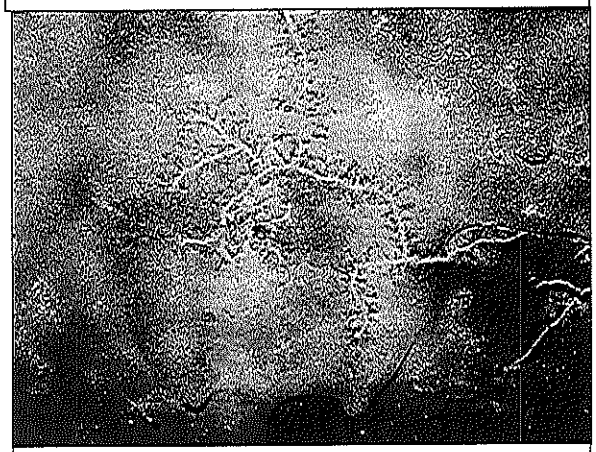


Figure 18. In wetter lava tubes large portions of the surface may be covered with a slime, on which the larvae of crane flies (*Limonia* sp.) leave characteristic trails. © near volcano Feb 2008

Invertebrates Not Present

Alien predatory ants are a major cause of low numbers of native arthropods. The big-headed ant (*Pheidole megacephala*), longlegged ant (*Anoplolepis gracilipes*), and carpenter ant (*Camponotus variegatus*), which prey on other insects (Zimmerman 1948-80), are present on the property. Ants are well documented as a primary cause of low levels of native arthropods at elevations up to 2000 ft. (Perkins 1913). On all nights, during light censusing, ants quickly appeared and began attacking the resting moths and smaller insects at my light. Ant populations often do not overlap. Rather they have separate territories, effectively apportioning the hunting grounds between themselves, offering few ant-free zones to native arthropods.

MOLLUSCA

Gastropoda (Snails) Pulmonata

No native snails were observed on the project property.

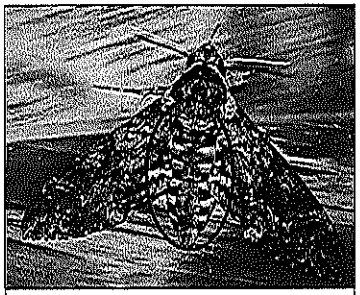
ARTHROPODA

Diptera: Drosophilidae: *Drosophila*

No native *Drosophila* (picture-winged flies) were observed on the property. The location does not provide appropriate habitat for any of the 12 native *Drosophila* species recently listed as endangered or threatened. (USFWS 2006a, b).

Lepidoptera: Sphingidae:

Agrius cingulata Sweet potato hornworm



© Figure 19. Sweetpotato hornworm showing pink markings.

The sweet potato hornworms feed on all sweet potato, morning glory, and related plants. Although it did not respond to my light survey, it is very likely to be seen on the property as it is widely distributed around the Hawaiian Islands and appropriate host plants are present. (HBS 2002a, Nishida 2002) This large and easily seen moth is most easily confused by the public with the Blackburn's sphinx moth (*Manduca blackburni*) described below. The adult *A. cingulata* having PINK markings (Figure 19) along both sides where *Manduca* has orange (Figure 20). When the moth is at rest with wings folded, these color markings are hidden, leading to possible misidentifications.

Manduca blackburni

Blackburn's sphinx moth (*Manduca blackburni*), (Figure 20) an endangered species (Fed Reg 1999-2000) which favors leeward slopes, was not found in this survey. Neither the moth's solanaceous native host plant, 'aiea (*Nothocestrum* sp.), nor the best alien host, tree tobacco (*Nicotiana glauca*), were observed on the property in my own survey or the most recent botanical survey (Whistler 2006). *Capparis sandwichiana*, reported to be adult nectar plants is known on the property. Whenever the plants were encountered in my surveying, I was alert for adults feeding on blooming flowers. *Manduca* was not observed.

© Figure 20. Blackburn's sphinx moth is distinguished from other hawk moths by orange markings.

Although the original *Recovery Plan* (USFWS 2005b) for this large sphinx moth proposed two small management areas in North Kona, Hawai'i, the *Final Rule* (USFWS 2003) designated habitat only at the more inland location, Pu'uwa'awa'a.

Orthoptera: (Praying Mantis, Grasshoppers, Crickets)

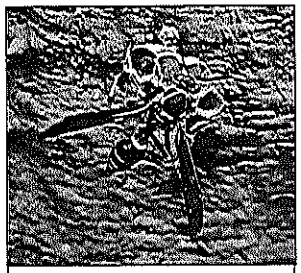
Gryllidae

Caconemobius anahulu Otte, 1994 Lava cricket

This species was first discovered by Dr. D. Otte on barren lava 1 km from 'Anaeho'omalu Bay, Hawai'i Island. In his major revision of Hawaiian crickets Otte writes this species "may be widespread along the western slopes of Hawaii Island." (Otte 1994) It is much less common than *Gryllodes sigillatus* (see page 16) in these extremely barren lavas at Kaloko Makai. Although not found in this survey, it is likely a longer search at another time of year would have recovered this species.

Medically important species

The Kaloko Makai project area includes classic habitat for centipedes, scorpions, and widow spiders, so these medically important species may be present in the area. *Dysdera crocota* , a 10-14 mm spider known to bite humans (page 12), and scorpions were seen inside the lava tubes and in the rocky areas. Common paper wasps (*Polistes exclamans*) (Figure 21) were seen repeatedly on the property. Employees should be alert for these species when working in the area. These species may pose a serious risk to some individuals, and supervisors should be aware of any special allergy of employees. Some individuals can experience anaphylactic reactions to venom. Also note that the ant species reported present (see page 24) are known to bite people. When moving stones or piled brush, use of gloves and long sleeves will greatly reduce the risk of accidental contact and bites with all species noted here. Please see *What Bit Me?* (Nishida & Tenorio 1993) and *What's Bugging Me?* (Tenorio & Nishida 1995).



© Figure 21. Paper wasp

POTENTIAL IMPACTS

Potential Impacts on Native, Rare, Federally or State Listed Species

No federally or state listed endangered or threatened species were noted in this survey (USFWS 2008). No anticipated actions related to the proposed project activity in the surveyed locations are expected to threaten an entire species.

RECOMMENDATIONS

Data retrieval

Decapoda

As the presence of the crab remains I observed in my survey had been marked by the archaeological surveyors, they were not collected. A consultation with B. P. Bishop Museum specialists shows that no specimens of this sort have been closely examined by scientists knowledgeable in this group. As the examples in these caves are in relatively good condition, they should be retrieved for specific identification by invertebrate specialists as part of the archaeological data recovery and mitigation process. During data retrieval, a search should be made for additional parts of the crab to aid in identification (i.e., lifting rocks, looking for smaller parts of the crab). Proper and specific identification will provide valuable information to increase both biological and cultural knowledge.

Prevent habitat degradation:
Fulfillment of the plan to preserve some archaeological sites and parts of the dry forest habitat should assist native invertebrate species, including cave adapted species. Selective removal of alien plants in these areas can assist native plants in filling the available niches. Additionally, it is important to prevent establishment of new competitive or predatory alien invertebrate species.

A **Best Practices Management Plan** for construction should be written and implemented specifying methods and controls for the entire construction zone to prevent or minimize runoff, spills, and impact on the makai coastal habitats (Kaloko-Honokōhau National Historical Park) as well as fragile archaeological and biological zones within the property. Establish construction staging areas and storage of materials well away from the fragile areas.

Two factors influence establishment of alien species: access and regular food sources.

Inspect construction materials for hitchhiking seeds or animals.

Clean tools, boots, and equipment used at other sites to minimize the chance of transporting new pest plants or animals to the area. Soil packed in tires, on helicopter runners, or workers' boots can transport seeds, and insect or snail eggs. Ants, snails and slugs, and many other invertebrates can hide in boxes or equipment resting at one location and later be carried to Kaloko Makai.

When establishing plantings after construction, care should be taken to prevent alien plant or animal species from being introduced on the plantings or associated soil.

Remove trash regularly. Predatory species such as ants easily establish in areas where food trash is consistently available. Food trash during construction can increase mongoose (*Herpestes auropunctatus*) populations as well. Construction workers are socialized to simply drop food remains and food wrappers, bottles and containers. Change expectations: Provide trash cans, establish a culture of using them, and empty the cans frequently.

Shield external lighting:
We concur with the advice of David (2006) to shield outdoor lighting. Light is attractive to all arthropods (see *Methods* page 7). The potential presence of *Manduca blackburni* in the greater area makes shielded lighting an important protection for this endangered invertebrate.

Landscape with native dryland plants for lower cost maintenance:

We concur with the advice of Whistler (2006) to revegetate public and common areas with native dryland adapted plants. Given the Kona climate of the project area, it would be both practical and appropriate. Native plants would provide habitat for native arthropods, while creating interesting areas for walking, cultural learning, nature study, and bird watching. Importantly, using dryland plants to landscape can lower long-term watering costs and water draws, following an initial establishment period. Native plants will remain green and thus more fire resistant throughout the summer. Most native plantings will have lower human maintenance costs as well (less hedge trimming, weed whacking). Planted in a mix of ground cover, shrub, and tree heights native plants also help slow run off and retain moisture when rains do come. Native plants usually grow well without the use of fertilizers, reducing the potential for runoff into Kaloko-Honokōhau National Historical Park (David 2006). Native insects will find this refuge over time. The plantings will provide educational, visual, and aesthetic benefits to residents while conserving water at very low on-going cost.

Home buyers should be given guidance on xeriscaping with restrictions being considered as part of covenants or homeowner association rules. Plants that are adapted to dryland areas also will not require doses of fertilizer and pesticides and so reduce non-point pollution. Several southwestern U. S. continental cities have long enforced water / yard planting restrictions due to water concerns. Their experiences may prove helpful in planning.

Resources helpful in understanding Hawaiian plants in an urban setting include *Native Hawaiian Plants For Landscaping, Conservation, and Reforestation* (Bornhorst & Rauch 1994) and *Growing Native Hawaiian Plants* (Bornhorst 2005). By prior arrangement with growers, native Hawaiian plants can be as convenient to mass plant as the introduced plants commonly used to re-vegetate after new construction. Some suppliers of native plants are listed at

http://hbs.bishopmuseum.org/botany/riparian/pdf/propagators.pdf

Some plants have demonstrated their adaptation to the area by growing at the Kaloko Makai site naturally [marked with asterisk (*) in the list below]. Dryland adapted plants suitable for landscaping, many with beautiful foliage or flowers, are listed below. Comments on some of the plants follow.

Ground cover:

'Ilima	*Sida* sp. (prone) (*)
malapilo	*Capparis sandwichiana* (*)
nehe	*Melanthera integrifolia, Melanthera subcordata*
'ohai	*Sesbania tomentosa*
pā'ūohi'iaka	*Jacquemontia ovalifolia*
pili grass	*Heteropogon contortus* (*)
'ulei	*Osteomeles anthyllidifolia*

Shrub:

'a'ali'i	*Dodonaea* sp. (*)
'ākia	*Wikstroemia* sp.
'ille'e	*Plumbago zeylanica*
'ilima	*Sida* sp. (upright) (*)
naio	*Myoporum sandwicense* (*)
pōhinahina	*Vitex rotundifolia*

Tree:

kou	*Cordia subcordata*
milo	*Thespesia pupulnea*
'ohe makai	*Reynoldsia sanwicensis* (*)
'ōhi'a lehua	*Metrosideros polymorpha* (*)
wiliwili	*Erythrina sandwicensis*

'A'ali'i / *Dodonaea* sp.

'A'ali'i (Figure 22) grows at roughly shrub height without hedge trimming. It produces flowers and foliage useful in lei making and is host to several invertebrates. It stays green year round without watering.

© Figure 22. 'A'ali'i *Dodonaea* sp. foliage and blossoms

'Ilima / *Sida* sp.

Figure 23. 'Ilima *Sida* sp.

'Ilima (Figure 23) is host to a large number of native invertebrates, maintains color and foliage during the dry months and needs little maintenance. It grows in a prone, ground cover form and an upright, shrub form. The plant will grow at seaside or inland locations.

Malapilo / *Capparis sandwichiana*)

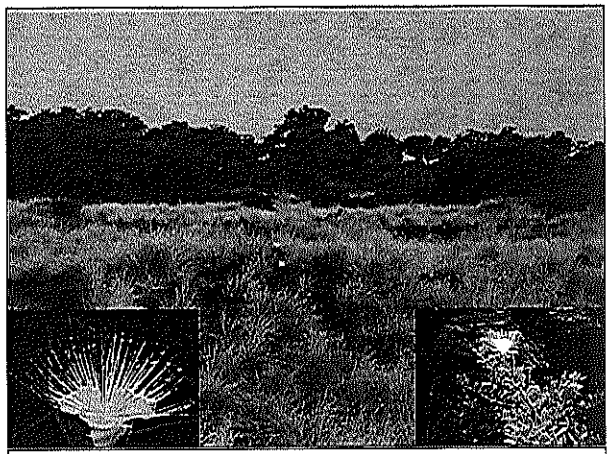
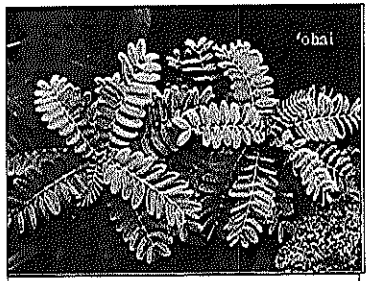


Figure 24. Malapilo (*Capparis sandwichiana*) [center] blooming amidst native pili and alien fountain grasses.

Malapilo (Figure 24), host to several native arthropods, is well adapted to the Kaloko Makai site. The plant bears numerous white flowers, which wilt to a beautiful pink as the day progresses. Already growing on site, malapilo, planted as a ground cover, provides nectar, pollen, and keeps down weeds. Morning walkers and joggers would find them a special attraction.

'Ohai / *Sesbania tomentosa*

Once known from all major islands, 'Ohai (Figure 25) now is rare outside planted areas. It has beautiful, moisture retaining, silvery leaves and dark orange, curved blossoms. It is a short shrub and stays 'green' all summer.



© Figure 25. 'Ohai *Sesbania tomentosa*

'Ōhi'a lehua (*Metrosideros polymorpha*)

'Ōhi'a lehua (Figure 26) can be a bush or tree and is well known for its attractive flowers much desired for lei making. It is now used more frequently in home landscaping on all islands. It could be planted in common areas at Kaloko Makai. In addition to the red flower, there are also other colors.

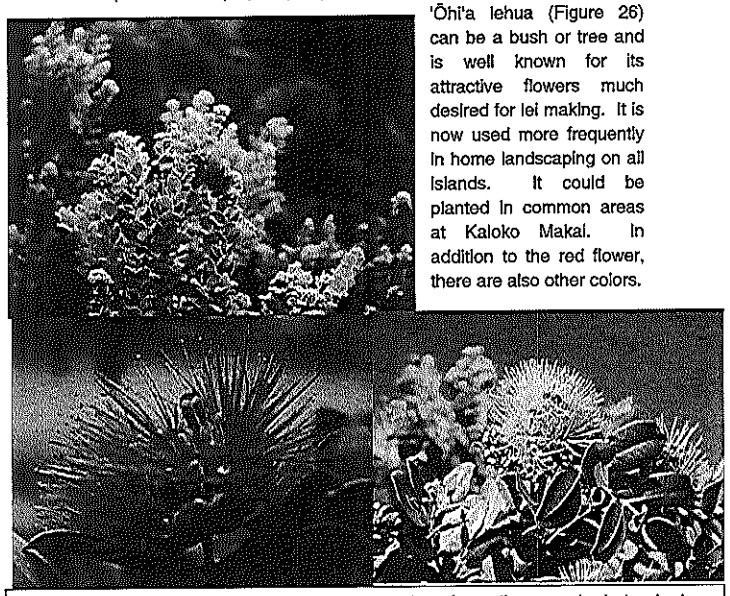


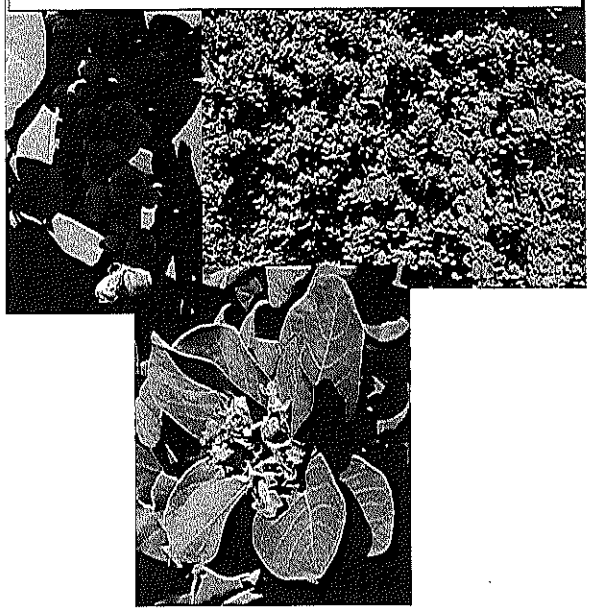
Figure 26. The species name of 'ōhi'a lehua, *polymorpha*, refers to the many physical and color varieties encompassed by the species.

'Ōhi'a is host to many native insects. As it provides a dependable nectar source for birds, the trees would make a reliable location for bird watching when in bloom.

Pōhinahina / beach vitex / *Vitex rotundifolia*

Now considered a beach plant (Figure 27), this hardy, flowering creeper likes to cascade over rocky areas or down small slopes but will form hedges. It will easily grow in upland locations. It tolerates abuse associated with human co-habitation, and even responds to pruning. It would form a natural hedge along pathways, thus keeping people on pathways with grace, beauty, and low upkeep. Spicy smelling leaves, small blue flowers, and brown seed capsules create visual interest. No watering required after establishment. Foliage, flowers, and seed capsules are all good lei making materials.

© Figure 27. Pōhinahina seed capsules, foliage, and flower



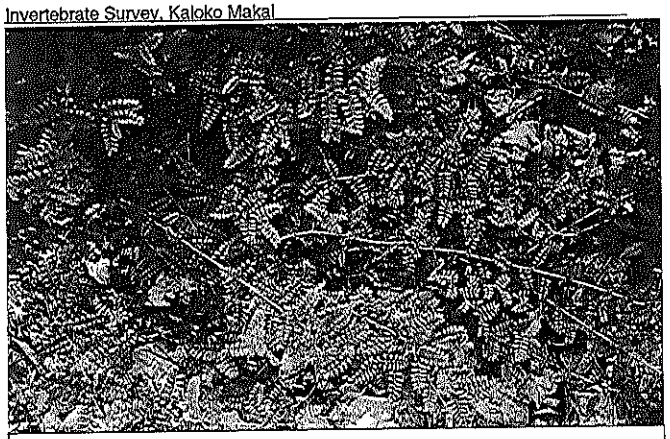
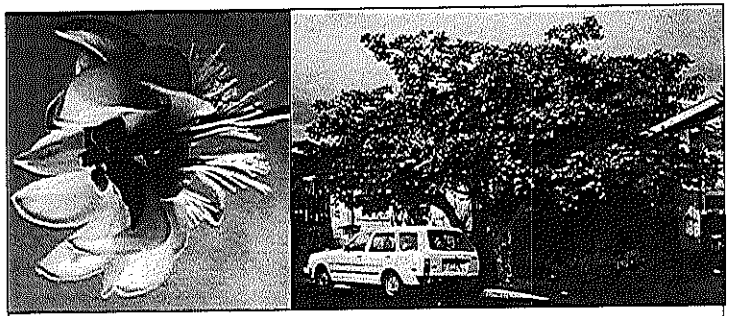


Figure 28. 'Ulei (*Osteomeles anthyllidifolia*)

'Ulei *(Osteomeles anthyllidifolia)*
'Ulei is a low growing plant (Figure 28) making a good ground cover, sometimes combined with other plants. It will grow in open areas or semi-shade. It is slower growing than some plants.

wiliwili / *Erythrina sandwicensis*



© Figure 29. Wiliwili is dryland adapted and needs no watering

Wiliwili (Figure 29) has a proven track record as a dryland decorative, low maintenance planting, co-habiting with homes and parks. Seasonal flushes of flowers provide remarkable beauty. The seeds make beautiful lei.

© Figure 30. Wiliwili receives solar energy through green bark when leaves are dropped.

Although currently wiliwili is under attack from a recently introduced alien gall wasp, a control agent of that pest is expected soon. Wiliwili is summer deciduous - dropping its leaves in summer and relying on minimal photosynthesis through green bark (Figure 30). Native wiliwili have suffered less from the wasp's attacks than the alien *Erythrina* trees, in part because their green bark provides some nutrition during periods when leaves are reduced by the wasp's effect.

Community Education:
The best defense the fragile dry forest ecosystems can have is an informed public. Providing signage and partnering with community environmental groups to provide information and guidance about enjoying the preserved dry forest, archaeological, and natural features, would make preservation more effective. Providing defined pathways would reduce trampling of plants and disturbance of wildlife.

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Steven Lee Montgomery conducted all collecting and is responsible for all conclusions. Anita Manning contributed to preparation of this report. Some images used in this report were not taken in the course of this project. These photos, marked by © symbol were made by Anita Manning and/or S. L. Montgomery prior to this contract and were chosen because they best illustrate the subject.

STANDARD NOMENCLATURE

Bird names follow *Hawaii's Birds* (Hawaii Audubon Society 2005).
Invertebrate names follow
Freshwater & Terrestrial Mollusk Checklist (HBS 2002b)
Common Names of Insects & Related Organisms (HES 1990)
Hawaiian Terrestrial Arthropod Checklist (HBS2002a; Nishida 2002)
Mammal names follow *Mammals in Hawaii* (Tomich 1986).
Place name spelling follows *Place Names of Hawaii* (Pukui et al. 1976).
Plant names follow
Manual of the Flowering Plants of Hawaii (Wagner et al. 1999)
A Tropical Garden Flora (Staples and Herbst 2005)

ABBREVIATIONS

ASL	above mean sea level
DLNR	Department of Land and Natural Resources, State of Hawai'i
DOFAW	Division of Forestry and Wildlife, State of Hawai'i
FOIA	Freedom of Information Act Request
ft	feet
HBS	Hawai'i Biological Survey
m	meter
MV	Mercury Vapor
n.	new
sp.	species
spp.	more than one species
TMK	Tax Map Key
UH	University of Hawai'i
USFWS	United States Fish and Wildlife Service
UV	Ultraviolet

GLOSSARY[4]

Adventive: organisms introduced to an area but not purposefully.
Alien: occurring in the locality it occupies ONLY with human assistance, accidental or purposeful; not native. Both Polynesian introductions (e.g., coconut) and post-1778 introductions (e.g., guava, goats, and sheep) are aliens.
Arthropod: insects and related invertebrates (e.g., spiders) having an external skeleton and jointed legs.
Aspiration: invertebrates are transferred from the original location (leaf, net, etc.) into a large vial. Two tubes are lodged in one stopper in the vial. Air drawn in on one tube, creates suction at the end of the second tube; the target insect is drawn into the vial by the pulling air.
Endemic: naturally occurring, without human transport, ONLY in the locality occupied. Hawaii has a high percentage of endemic plants and animals, some in very small microenvironments.
Gibbous: describes the Moon or a planet before and after it is full, when it has more than half its disk illuminated; swollen on one side.
Indigenous: naturally occurring without human assistance in the locality it occupies; may also occur elsewhere, including outside the Hawaiian Islands. (e.g., Naupaka kahakai (*Scaevola sericea*) is the same plant in Hawai'i and throughout the Pacific).
Insects: arthropods with six legs, and bodies in 3 sections
Invertebrates: animals without backbones (insects, spiders, snails / slugs, shrimp)
Larva/larval: an immature stage of development in offspring of many types of animals.
Makai: toward the ocean
Mauka: toward the mountains
Midden: food refuse in an archaeological setting, often in a heap or pile
Mollusk: invertebrates in the phylum Mollusca. Common representatives are snails, slugs, mussels, clams, oysters, squids, and octopuses.
Morph: one form of a polymorphic (or many formed) population which despite their physical differences are part of the same genus or species.
Native: organism that originated in area where it lives without human assistance. May be indigenous or endemic.
Naturalized: an alien organism that, with time, yet without further human assisted releases or plantings, has become established in an area to which it is not native.

4 Glossary based largely on definitions in *Biological Science: An Ecological Approach*, 7th ed., Kendall/Hunt Publishing Co., Dubuque, a high school text; on the glossary in *Manual of Flowering Plants of Hawai'i*, Vol.2, Wagner, et al., 1999, Bishop Museum Press, and other sources.

Glossary: cont.

Nocturnal: active or most apparent at night.
Pupa: the stage between larva and adult in insects with complete metamorphosis, a non-feeding and inactive stage often inside a case
Purposefully introduced: an organism brought into an area for a specific purpose, for example, as a biological control agent.
Rare: threatened by extinction and low numbers.
Species: all individuals and populations of a particular type of organism, maintained by biological mechanisms that result in their breeding mostly with their kind.
Waning: describes a gradual decrease in the amount of the moon's disk that is visible; shrinking

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Appendix J

Summary Report of Archaeological Inventory Survey for Kaloko Makai Cultural Surveys Hawaii, Inc. May 2008

The Archaeological Inventory Survey (March 2008 and May 2008) consists of seven volumes. The complete report has been filed with Department of Land and Natural Resources State Historic Preservation, the Office of Environmental Quality Control, State Land Use Commission, and Office of Hawaiian Affairs.

Kaloko Makai Project Draft EIS Draft Summation of Archaeology

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INTRODUCTION

Project Background

At the request of Stanford Carr Development, LLC, Cultural Surveys Hawai'i, Inc. (CSH) conducted archaeological inventory surveys covering the entire Kaloko Makai project lands. Given the large size of the total project area (over 1,100-acres) and the large number of archaeological sites identified (341) the work has been organized within separate studies for each of the four Tax Map Key parcels (TMK: [3] 7-3-009:017, 025, 026 & 028) as follows:

- *Archaeological Inventory Survey of a 224.43-Acre Parcel within Portions of Kaloko and Kohanaiki Ahupua'a, North Kona District, Hawai'i Island TMK: [3] 7-3-009:017* (Bell, Groza, Shideler, and Hammatt 2008),
- *Archaeological Inventory Survey of a 360.131-Acre Parcel within Portions of Kohanaiki Ahupua'a and Kaloko Ahupua'a, North Kona District, Hawai'i Island TMK: [3] 7-3-009:025*(Bell, Groza, Simonson, Shideler, and Hammatt 2008),
- *Archaeological Inventory Survey of a 194.324-Acre Parcel within portions of Kohanaiki Ahupua'a and Kaloko Ahupua'a, North Kona District, Hawai'i Island TMK: [3] 7-3-009:026* (Bell, Simonson, Esh, Groza, Shideler, and Hammatt 2008), and
- *Archaeological Inventory Survey of a 363.106-Acre Parcel within Portions of Kaloko Ahupua'a, North Kona District, Hawai'i Island TMK: [3] 7-3-009:028* (Esh, Bell, Simonson, Shideler, and Hammatt 2008)

The work to prepare these studies was carried out between March 2007 and April 2008 and involved approximately 6 archaeologist-years of work.

Historic Preservation Regulatory Context and Document Purpose

As a privately funded venture on private lands, the proposed development is a "project" subject to state of Hawai'i historic preservation review legislation (Hawaii Revised Statutes [HRS] Chapter 6E-42 and Hawai'i Administrative Rules [HAR] Chapter 13-284). Based on the project's scope, cultural setting, and the results of previous cultural resource management investigations in the vicinity, Stanford Carr Development, LLC had these archaeological inventory survey investigations completed. These investigations were carried out as part of and in compliance with the proposed development's historic preservation review.

Under Hawai'i state historic preservation legislation, archaeological inventory surveys are designed to identify, document, and provide significance and mitigation recommendations for historic properties. Under this legislation, historic properties are defined as any "building, structure, object, district, area, or site, including *heiau* and underwater site, which is over fifty years old." A project's effect and potential mitigation measures are evaluated based on the project's potential impact to "significant" historic properties (those historic properties determined eligible, based on established significance criteria, for inclusion in the Hawai'i Register of Historic Places [Hawai'i Register]). Determinations of eligibility to the Hawai'i Register result when a state agency official's historic property "significance assessment" is approved by the State Historic Preservation Division (SHPD), or when SHPD itself makes an eligibility determination for an historic property (HAR Chapter 13-284).

In consultation with SHPD, these inventory survey investigations were designed to fulfill the state requirements for archaeological inventory surveys (HAR Chapter 13-276). The inventory survey reports were prepared to support the proposed project's historic preservation review. The reports include project-specific effect recommendations and mitigation recommendations for the project area's historic properties that are recommended eligible to the Hawai'i Register. These documents are intended to support project-related historic preservation consultation among state agencies and interested Native Hawaiian and community groups.

Scope of Work

The following archaeological inventory survey scope of work was developed and implemented to satisfy SHPD requirements. The scope of work for this inventory survey was designed in accord with State Historic Preservation Division rules governing standards for archaeological inventory surveys and reports (HAR 13-13-276):

1) Appropriate consultation with knowledgeable members of the community, requesting information on historic properties in the project area.
2) A complete ground survey of the entire project area for the purpose of historic property identification and documentation. All historic properties would be located, described, and mapped with evaluation of function, interrelationships, and significance. Documentation is to include photographs and scale drawings of selected historic properties. All historic properties are to be assigned *Inventory of Historic Properties* numbers by the State.
3) Subsurface testing to determine if subsurface deposits are located in the project area, and, if so, evaluate their significance. If appropriate samples from these excavations were found, they were analyzed for chronological and/or paleoenvironmental information.
4) Research on historic and archaeological background, including search of historic maps, written records, and Land Commission Award documents. This research was to focus on the specific area with general background on the *ahupua'a* and district and was to emphasize settlement patterns.
5) Preparation of a survey report to include the following:
    a. A topographic map of the survey area showing all historic properties;
    b. Results of consultation with knowledgeable community members about the property and its historical and cultural issues.
    c. Description of all historic properties with selected photographs, scale drawings, and discussions of function;
    d. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the project area's historic properties;
    e. A summary of historic property categories and their significance in an archaeological and historic context;
    f. Recommendations based on all information generated that will specify what steps should be taken to mitigate impact of development on the project area's significant historic properties, 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 includes full coordination with the State Historic Preservation Division (SHPD) relating to archaeological matters. This coordination takes place after consent of the landowner or representatives.

METHODS

Field Methods

The fieldwork effort for the archaeological inventory surveys was carried out by Matthew Bell, B.A., Mindy Simonson, M.A., David Shideler, M.A., Kelley Esh, M.A., Jason Pickin, B.A., Shawn Fehrenbach, B.A., Sarah Wilkinson, B.A., Randy Groza, M.A., Amy Hammermeister, B.A., Todd McCurdy, M.A., Michelle Pammer, B.A, Doreen Hrivnak, B.A., Mark Oxley, B.A. and Hallett H. Hammatt, Ph.D (principle investigator).

The fieldwork component of the archaeological inventory survey was carried out under archaeological permit numbers 07-19 and 08-14 issued by the Hawai'i State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawai'i Administrative Rules (HAR) Chapter 13-282.

Fieldwork consisted of a 100% coverage pedestrian inspection of each of the four study areas with subsurface testing at select archaeological sites. The pedestrian inspection of the study areas was accomplished through systematic sweeps. The interval between the archaeologists was generally 5 to 10 meters, varying based on visibility due to vegetation cover. Overall, heavy vegetation throughout the parcels was an impediment to ground and site visibility, and relatively narrowly spaced survey lines attempted to mitigate this issue. All historic properties encountered were recorded and documented with a written field description, scale drawings, photographs, and located with high quality GPS units including Garmin 60CSx high sensitivity units (accuracy +/- 3 m). Sites requiring the highest precision available, such as those recommended for preservation, were further located using Trimble Pro XR GPS survey technology (accuracy +/- 1 m).

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 aid in determining the function of located surface sites, as well as to possibly obtain datable materials for later radiocarbon dating. In order to focus subsurface testing at sites with the best excavation potential, depth of deposits or construction was assessed as part of determining excavation potential. This assessment consisted of careful observation of the depth of crevices, stacked rock and piled rock that included careful removal and replacement of small portions of the top course of construction. In the event this minor removal of material allowed a natural ground surface to be observed and an absence of cultural material to be confirmed, excavation potential was generally observed to be poor. Otherwise, if necessary to determine or confirm function, a formal excavation was generally undertaken and reported in detail in conjunction with the respective site description.

All excavated material was sifted through a 1/8-inch wire mesh screen to separate out the soil matrix. Any cultural material was collected for analysis in the lab, except in the event excavation determined the site was a burial (or probable burial) in which case cultural material was carefully returned to the excavation. 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. While a stratigraphic profile is usually generated for at least one soil profile per test unit, most excavation units during the inventory survey had very shallow soil layers, if any. Some soil layers encountered consisted only of a shallow natural deposition with no cultural material, and few excavation units had more than one significant soil stratum present. Graphic presentations would thus not aid in most strata description and were therefore not included with some testing results.

Recording Agricultural Sites

Agricultural features are pervasive in a low density throughout the project area. The majority of these features tended to be minimal modification, low energy-investment and spread over broad areas (sometimes over several hundred meters). For recording purposes, a site number was given to the pervasive agricultural features within each project area, with feature and sub-feature designations serving to differentiate various levels of intensity and variations in form. The far *mauka* portion of the northeastern project area (TMK: [3] 7-3-009:026) is subject to higher rainfall and has a large area of higher density and more formal agricultural modification that is noticeably more intense than the agricultural activity in the rest of the Kaloko Makai project area. This *mauka* area is consistent with the expansive Kona Field System (SIHP # 50-10-28-6601) and was recorded as a portion of that larger site. Minor agricultural activity associated directly with a site primarily functioning for other purposes (i.e., habitation), was included in the description for that site.

Recording Lava Tubes

Lava tubes are ubiquitous within portions of the Kaloko Makai project area, especially on the *pāhoehoe*, and vary greatly in size and shape. All openings in the bedrock were examined for the presence of cultural modification or cultural material. Any opening that appeared large enough to explore was examined thoroughly. Generally, an average size person can fit through a tube entrance 30 centimeters in diameter or greater, but the shape and geology of lava tubes varies greatly and occasionally a smaller size opening could be entered; likewise, sometimes a larger than 30 centimeter opening could not be traversed due to jagged edges, etc. Every effort was made to explore the entirety of all lava tubes to their terminus, within reason as far as tube size and safety (i.e., heavily collapsed tubes were entered with caution). When a tube can no longer be explored due to size or safety, this is considered its cultural terminus, and is denoted as impassable on maps. It should be noted that cultural material and burials have been located in lava tubes with entrances which were only barely physically passable, even for the most petite archaeologists in our group.

The primary purpose for the intensive exploration of lava tubes is to locate any human remains that may be present in remote areas of a lava tube, in addition to locating other cultural material. Lava tubes were traditionally used for concealment of burials, and human remains are often located far from any other cultural modification, sometimes at great distances from tube entrances; these burials may have been placed in the lava tube using an entrance that was then filled and concealed on the surface. Therefore, in an effort to locate all burial locations within the project area, a thorough effort was made to explore all lava tubes and side tubes to their natural or cultural terminus.

As mentioned above, human utilization of lava tubes sometimes involved blockage of entrances and inner side tubes. In order to complete the inventory survey, it was necessary to pass this type of blockage; when possible, this was done by finding another passageway for access behind the blockage or attempting to assess what was behind the blockage (i.e., solid lava tube wall vs. a continuing passageway) without disturbing the blockage. If it was determined that the tube did continue past blockage and there was no other way to access the tube, a photo was taken of the blocked area and then rocks were carefully removed until an archaeologist could pass through. After inspection of the lava tube, the rocks were replaced as carefully as possible to their original position.

All lava tubes with cultural material present were mapped using a compass for bearing and a laser for distances (Stanley FatMax Tru-laser Distance Measurer; stated accuracy for this device is +/- 6 cm). The laser reflects well off most surfaces in tubes, and is an excellent alternative to the rather impractical method of pulling measuring tapes through cramped areas, or simply estimating distances (it is extremely difficult to accurately estimate distances in lava tubes; see Wolforth 2005:24). The laser method may actually increase the efficiency of mapping tubes, since accurate measurements can be obtained nearly instantaneously; overall the this technology seems to produce more accurate maps than simply estimating distances in about the same amount of time. In small tubes a regular measuring tape was used when practical.

Occasionally lava tubes extend long distances beyond any cultural modification. When this occurs, lava tubes are explored to their natural or cultural terminus. Maps are produced for all areas containing cultural materials, and the rest of the lava tube is described but not necessarily mapped. A distance and bearing from the site tag is given for all burials within lava tubes.

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 dating.
2. Identification of invertebrate midden. Common marine shells were identified and analyzed at the Cultural Surveys Hawai'i laboratory in Kailua, Hawai'i.
3. Identification of vertebrate faunal material. All vertebrate faunal material was identified and analyzed at the Cultural Surveys Hawai'i laboratory in Kailua, Hawai'i.
4. Identification and cataloguing of traditional Hawaiian artifacts. Any artifacts collected *in situ* at the project area or contained within sediment samples were measured, weighed and classified by material type and artifact form. The analysis then focused on distinguishing artifact function.

Document Review

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division (SHPD) of the Department of Land and Natural Resources (DLNR); a review of geology and cultural history documents at Hamilton Library of the University of Hawai'i, the Hawai'i State Archives, the Mission Houses Museum Library, the Hawai'i Public Library, and the Archives of the Bishop Museum; study of historic photographs

at the Hawai'i State Archives and the Archives of the Bishop Museum; and a study of historic maps at the Survey Office of the DLNR and the Land Survey Division of the Department of Accounting and General Services. Information on LCAs was accessed through Waihona 'Āina Corporation's Māhele Data Base (www.waihona.com).

This research provided the environmental, cultural, historic, and archaeological background for the project area. The sources studied were used to formulate a predictive model regarding the expected type and location of sub-surface pre and post-contact historic properties in the project area.

Consultation

A cultural impact assessment (Hammatt & Shideler 1996) was conducted for TMK 7-3-09:17, in 1996. Informants knowledgeable of TMK 7-3-09:17 and the project area vicinity were interviewed. These consultations focused on identifying traditional cultural practices conducted adjacent to the project area as well as addressed community concerns regarding possible burial sites.

Cultural Surveys Hawaii, Inc. is currently conducting consultation with organizations and the community to identify *kūpuna* and other individuals with knowledge of the history of the project area and its surroundings. The results of these interviews will be presented in a companion report for this project, titled "Cultural Impact Assessment for a 1,150-Acre Parcel within portions of Kohanaiki and Kaloko Ahupua'a, North Kona District, Hawai'i Island TMK: [3] 7-3-009:017, 025, 026, 028" (Monahan et al. 2008). This CIA will include consultation for all four parcels within the Kaloko Makai project. The on-going consultation with organizations includes the State Historic Preservation Division (SHPD), the Office of Hawaiian Affairs (OHA), and the Hawai'i Island Burial Council.

Further consultation will be conducted in the course of the preparation of project burial treatment and site preservation plans.

BACKGROUND RESEARCH

A synopsis of the background research is presented below. More detailed background research is presented within each of the four archaeological inventory survey studies.

Traditional and Historical Background

Mythological and Traditional Accounts

The *ahupua'a* of Kohanaiki and Kaloko lie at the southern end of Kekaha, the portion of North Kona extending from Honokōhau to 'Anaeho'omalu. The character of Kekaha - as it had been established in the Hawaiian consciousness - is represented in a traditional saying recorded by Mary Kawena Pukui and in a brief description by John Papa 'Ī'ī. The saying, "*Kekaha wai 'ole na Kona*", is defined by Pukui as "waterless Kekaha of the Kona district" and explicated by her as "Kekaha in Kona, Hawai'i, is known for its scarcity of water but is dearly loved by its inhabitants" (Pukui 1983:184). 'Ī'ī describes:

> ...a cold wind from Kekaha, the Hoolua. Because of the calm of that land, people often slept outside of [sic] the tapa drying sites at night. It is said to be a land that grows cold with a dew-laden breeze, but perhaps not so cold as in Hilo when the Alahonua blows ['Ī'ī 1959:122].

These passages suggest that Kekaha was firmly identified with its austere physical environment. A legend told in Maguire (1966) reveals the importance of water resources in this general area. The story focuses on a man named Ko'amokumokuohe'eia, who moved to an upland area and was told by the residents there that water was very scarce. Water, he was told, could be found in "celebrated" caves, but these caves were *kapu* (forbidden), and trespassers would be killed by the owner of the cave. However, Ko'amokumokuohe'eia discovered a very small cave entrance that no else knew about. The cave had water dripping from its roof (Maguire 1966:30). Ko'amokumokuohe'eia and his father used carved *'ōhi'a* and *wiliwili* trees to capture the dripping water, and his family was thus able to survive during dry spells. This legend clearly demonstrates the importance of water as a difficult to procure resource, as well as highlighting the importance of water collection caves.

Describing the apportioning of land by the *ali'i* (royalty) before the ascendancy of Kamehameha, the pioneer nineteenth-century Hawaiian historian Samuel M. Kamakau records this information about the lands of Kekaha:

> Waimea was given to the Pa'ao kahuna class in perpetuity and was held by them up to the time of Kamehameha III when titles had to be obtained. But there was one land title held by the kahuna class for many years and that was Puuepa in Kohala. In the same way the land of Kekaha was held by the kahuna class of Ka-uahi and Nahulu [Kamakau 1961:231].

Kamakau further records that during the 1770s, "Kekaha and the lands of that section" were held by descendants of the Nahulu line, the Ka-me'e-ia-moku and Ka-manawa, the twin half brothers of Ke'e-au-moku, the Hawai'i island chief (Kamakau 1961:310).

Kamakau mentions Kaloko in an episode that suggests that *ahupua'a's* significance within the pre-contact Kekaha landscape. Kamakau recounts an extraordinary day's reconnaissance of the west coast of Hawai'i Island by the spy Ka-uhi-o-ka-lani, sent to the island by Kama-lala-walu, chief of Maui. Having reached Kawaihae by canoe at night, Ka-uhi-o-ka-lani "ran about that same evening [reaching as far south as Ka'awaloa] and returned before the canoes were dismantled..." Ka-uhi-o-ka-lani, recounting his journey and the landmarks he had observed, relates: "I went on to the long stretch of sand, to the small bay with a point on that side and one on this side. There are large inland ponds." He is told that the "sandy stretch is 'Ohiki, and the walled-in ponds are Kaloko and Honokōhau" (Kamakau 1961:56). This event unfolds during the time of the sixteenth-century Hawai'i Island *ali'i* Lono-i-ka-makahiki, suggesting that by the 1500s Kaloko and its fishpond were well-known features in the Kekaha landscape.

Intensive archaeological investigation during recent decades has clarified the picture of pre-contact Hawaiian life within Kekaha and the two *ahupua'a* under study. Especially detailed study of Kaloko has resulted in the following analysis of the development of pre-contact settlement throughout the *ahupua'a*:

> Throughout its span of occupation Kaloko was but part of a larger society. Kaloko was apparently a unified community after A.D. 1200-1300. When initially occupied

> (A.D. 1000-1500), it may have been an outlier of another community. Nevertheless, from its initial occupation, Kaloko had 1 or more internal local residence groups containing constituent households. By A.D. 1200-1300 at least 2 residential groups were present in the community, and by contact (circa A.D. 1778) at least 4 residential groups had dwelled in the area. Each residential group performed religious functions as well as being a leisure unit. Members of the group held use rights to adjacent farm lands and probably to areas where forest and marine resources were located. Within each residential group, 1 household seems to have been dominant, being the spatial focus for its group's religious activities. It is suggested that such dominance was a function of consanguineal seniority and/or wealth. (Cordy et al. 1993:45)

While exact population figures for Kaloko were not possible, the study suggested that the "community seems to have gradually grown in size but could never have been larger than 118 and most likely was about 60-100 in size" (Cordy et al. 1993:45). The general pattern of land use and settlement suggested for Kaloko may also have existed within the similar environment of neighboring Kohanaiki.

A detailed study of Kaloko by Cordy et al. (1991) for the National Parks Service has developed a model of pre-contact settlement throughout the *ahupua'a*. The following is a summary of this model provided by the National Parks Service (2001):

> Permanent settlements in the leeward portions of Hawai'i Island began by the A.D. 900s to 1000s, and possibly earlier. These would have occurred near favorable water sources, Kaloko bay probably having been one of the most sheltered and inviting large inlets along the Kona Coast. Coastal habitations had expanded by the 1200s, utilizing inland fields as well as sea resources for subsistence. The Kekaha lands north of Kaloko and extending to Kohala are thought to have undergone initial permanent settlement beginning in the 1400s, with subsequent occupation of the coast north and south over the next few centuries.
>
> Sometime during the period of 1580 to 1600, Laeanuikaumanamana, the *kahuna-nui* of the ruling chief, Liloa, acquired the Kekaha region. It is thought that the construction of fishponds at Kaloko and Honokahau began during this time, with Kaloko Fishpond dating from at least the 1400s to 1500s. During the 1600s to 1700s, as the Kona Coast population grew with the establishment of the royal residence of 'Umi-a-Liloa at Kona and the consequent increased demand for food production, Kaloko also increased to probably almost 200 residents. It continually supported a higher population than other Kekaha areas because of its fishpond and extensive inland field system [National Parks Service 2001].

The general pattern of land use and settlement suggested for Kaloko may also have existed within the similar environment of neighboring Kohanaiki.

Into the last decades of the 18th century - following western contact - Kohanaiki and Kaloko - as elements of the larger Kekaha area -remained under the control of Ka-me'e-ia-moku, who resided to the north at Ka'ūpūlehu (Kamakau 1961:147).

Early Historic Period

By the first decades of the 19th century, the inhabitants of Kaloko and Kohanaiki would have long experienced the social pressures and consequences of western contact. "As early as 1788, Hawaiians began enlisting as seamen on the foreign ships that stopped at Island ports, and their number increased rapidly with the growth of whaling in the Pacific" (Schmitt 1973:16). As harbor facilities were developed at Kailua and Kealakekua during the early 1800s, these burgeoning ports became centers of a population drawn from increasingly isolated (economically and socially) areas like Kaloko and Kohanaiki. Newly-introduced diseases cut the population severely.

Kaloko is recorded by Kamakau as the site where Kamehameha's bones were cached after his death in 1819:

> Kamehameha had...entrusted his bones to Ulu-maheihei Hoa-pili with instructions to put them in a place which would never be pointed out to anyone. At midnight, therefore, when black darkness had fallen and no one was likely to be on the road and the rough lava plains of Pu'ukaloa lay hushed, Hoa-pili sent his man, Ho'olulu, to bring the container of wicker work in which the bones of Kamehameha were kept to Kaloko in Kekaha...The next morning Hoa-pili and Ke-opu-lani took canoe to Kaloko where Hoa-pili met the man who had charge of the secret cave and together they placed the bones there [Kamakau 1961:215].

Kamakau's account, if accurate, suggests that Kaloko's population, toward the end of the 19th century's second decade, had diminished to such an extent that the *ahupua'a* could provide the necessary isolation and secrecy for the burial.

Missionary censuses of the 1830s chart the diminishing population of Kekaha and North Kona. In 1834, the total population of Kekaha is recorded as 1,244, comprising 21% of the total North Kona population of 5,957 (Schmitt 1973:31). The North Kona figure represents a population loss of 692 since the previous census of 1831 (during which no figure specific to Kekaha was noted), which recorded 6,649 persons in the district (Schmitt 1973:9). One factor - inter-island migration - inducing the diminishing population of Kona was specifically noted by missionaries in 1832: "We have been sensible for some time that the number of inhabitants in this island is on the decrease. There is an almost constant moving of the people to the leeward islands, especially since the removal of the governor (Kuakini) to Oahu. Some leave by order of the chiefs, and others go on their own responsibility" (cited in Schmitt 1973:16).

Records generated during the 1840s for Land Commission Awards (LCAs) conferred at mid-century document the disposition of population and land use within Kohanaiki and Kaloko *ahupua'a* that had evolved since western contact. At the Māhele of 1848, Kaloko was claimed by and awarded (LCA 7715) to Lot Kamehameha (who would become Kamehameha V). Kohanaiki was classified as Government Land. Subsequently, 18 *kuleana* claims - by commoners claiming to occupy and/or cultivate land parcels - were made in Kaloko. Twelve of these claims were awarded. All claims were for *mauka* lands - between 1200 and 1700 ft. elevation - adjacent to or just *makai* of the Government Road. Only testimony for Kahiona's LCA 9205/9237 claim (which was not awarded) mentions a fishpond; no site within the coastal area is claimed. Farmlands claimed are *māla*, *kīhāpai*, and *mo'o*, i.e. forms of dry land agriculture; actual crops identified in the award testimonies are taro and sweet potato. Only five of the total 18 claims mention residence on or use of the Kaloko lands dating to the time of Kamehameha I, the first

decades of the nineteenth century; the remaining claims testify to residence/use beginning in the 1830s and 1840s.

Parcels within Kohanaiki, having become Government Land, were subject to sale - designated grants - by the Hawaiian government. Land sales began in the 1850s with Grant 2030 to Kaiakoili in 1856, awarding 102 acres adjacent to and *makai* of the Government Road. Also beginning in the 1850s, the first taxpayer rolls for Kohanaiki and Kaloko were documented: they indicate, within Kohanaiki, 8, 13 and 12 taxpayers during the years 1857, 1859 and 1860, respectively; within Kaloko, during the same years, 19, 21 and 23 taxpayers were recorded. Just past the middle of the 19th century, the populations of Kaloko and Kohanaiki have been drawn beyond the original subsistence-based economy into the western commercial paradigm.

As Cordy notes about Kaloko: "The historical documents suggest that by the 1840s-1850s, the Coastal Zone had been abandoned as a residential area, except probably for a house used by the fishpond's caretaker. This pattern would have been a stunning change from prehistoric and early historic times, when many coastal residences were present" (Cordy 1991:288). This pattern likely also held for Kohanaiki.

Mid- to late -1800s

The division of Kohanaiki - through sales of Government lands -continued throughout the remainder of the 19th and into the 20th century. Grant 2942 in 1864 awarded to Hulikoa 929.75 acres which included the width of the *ahupua'a*, extending *makai* from Kaiakoili's grant. In 1871, Grant 3086 awarded 154 acres to Kapena; this parcel extended *makai* from Hulikoa's grant to the shoreline.

Kaloko is documented during the 1870s in testimonies by Hawaiians before the government's Boundary Commission. Testifying on August 12, 1873, Nahuina (who had earlier received LCA 10327 in Kaloko) describes himself as "born at Kaloko North Kona Hawaii at the time of Keikepuipui, the building of the *heiau* at Kailua, and have always lived there" and states that the boundaries of Kaloko were shown to him by his father, the former *konohiki* of the *ahupua'a*. Identifying the *mauka* portions of the boundary, Nahuina notes bounds defined by vegetation and a wall (*iwi 'āina*), and recalls a former habitation site:

> ...From the *makai* side of Kaupulehu the boundary runs along said land, the koa being on Kaloko and the mamani and pukeawe [sic] on Kaupulehu to the corner of Lanihau 2nd Keahuolu and Honokohaunui...Ohiawela, a *pali*, on the road through the woods is a point on the boundary. This place is above Honokohaunui, thence turn makai to Kahua, a place in the fern where houses used to stand, from thence the boundary runs makai along an *iwi aina* to Kapokalani, at the Government road. Thence *makai* still following the *iwi aina* to Kiikii an *ili aina*, thence to Kaohe, a grove of trees thence to *aa*...

Nahuina adds that Kaloko has "ancient fishing rights extending out to sea." Testifying on the same date, Hoohia, who "moved to Honokohauiki when quite small and reside[s] there now", adds details that suggest the *mauka* Kaloko-Honokohau boundary was defined by different vegetation that also reflected former traditional gathering rights: "Honokohaunui ends at Ohiawela, a *pali*. Kaloko takes the *koa*, and Honokohaunui, the *ohia*...The *olona* grows on Honokohaunui and Kealakehe and the koa on Kaloko."

During the 1880s, Kona lands - including Kaloko and Kohanaiki - were surveyed by J. S. Emerson for the Hawaiian government. Emerson produced three maps corresponding to the project area during this time period: Registered Map (RM) 1280, RM 1449, and RM 1512 (Figure 1 and Figure 2). Figure 1 shows the locations of the three Kohanaiki grants described above, as well as "Kealiihelepa Hse" at the coast above the Kaloko fish pond and, near the government roads, "Kaloko Cath. Church" and "Kohanaiki Church". This is likely the Protestant church recorded as built by a minister, Kaanohimaka, and his congregation in the 1870s (Kelly 1971:14). A portion of Emerson's Registered Map (RM) 1449 and 1512 (Figure 2) show a trail through the current project area; the trail ran from the Kohanaiki Homesteads to the Kaloko fishpond. As noted by Cordy (1991:418), Emerson's map of the area including the Kohanaiki Church indicates "a set of about 16 stone house enclosures and a Protestant church, collectively called the Kohanaiki Homesteads"; Cordy suggests a "late 1880s age for the formation of the Kohanaiki Homesteads." The resident population in the late 1880s is understood to have been in a belt at the elevation of the Kohanaiki Church, Kaloko Catholic Church and Honokōhau School house shown on the Emerson map as located east of the present project lands at an elevation of greater rainfall. Kelly (1971) notes that the Kohanaiki Homesteads would draw people as other areas of North Kona were abandoned. Government records of Kohanaiki grants show 18 parcels ranging in size from .73 acres to 25.45 acres awarded from 1895 to 1904.

While all three Emerson maps are informative of the area, there are inconsistencies between them that are difficult to interpret. RM 1280 was likely produced with a somewhat different intent than the other two maps though they were all surveyed in such a short time period. Suggestive of the different intent, RM 1280 does not indicate survey stations as the others do. However, perhaps the largest inconsistency is the route of the two roads extending *makai* from the homesteads – on RM 1280 crossing into Kaloko just outside of the homesteads and on RM 1449 further *makai*. Since RM 1280 does not give a name to this road and the date of the map is somewhat uncertain, it could be that there were two roads, one superseding the other. It is also likely that RM 1280 was a simply a preliminary survey (if the dates for J. Perryman's sketches date the map) and was less accurate (didn't extensively use survey markers).

A few newspaper articles detailing life and the customs in Kekaha during the last half of the 19th century (written between 1928 and 1930) mention water collection. Kepā Maly (2003:41-42) translated serial accounts from *Ka Hōkū o Hawai'i* written by John Ka'elemakule Sr., a Kekaha native, and the following two excerpts demonstrate the significance of water catchment:

> There were not many water holes, and the water that accumulated from rain dried up quickly. Also there would be weeks in which no rain fell... The water which the people who lived in the uplands of Kekaha drank, was found in caves. There are many caves from which the people of the uplands got water... [*Ka Hoku o Hawaii*, September 17, 1929:3].
>
> ...The kūpuna had very strict *kapu* (restrictions) on these water caves. A woman who had her menstrual cycle could not enter the caves. The ancient people kept this as a sacred *kapu* from past generations. If a woman did not know that her time was coming and she entered the water cave, the water would die, that is, it would dry up. The water would stop dripping. This was a sign that the *kapu* of Kāne-of-the-water-of-life (Kaneikawaiola) had been desecrated. Through this, we learn that the ancient people of Kekaha believed that Kāne was the one who made the water drip from within the earth, even the water that entered the sea from the caves. This is

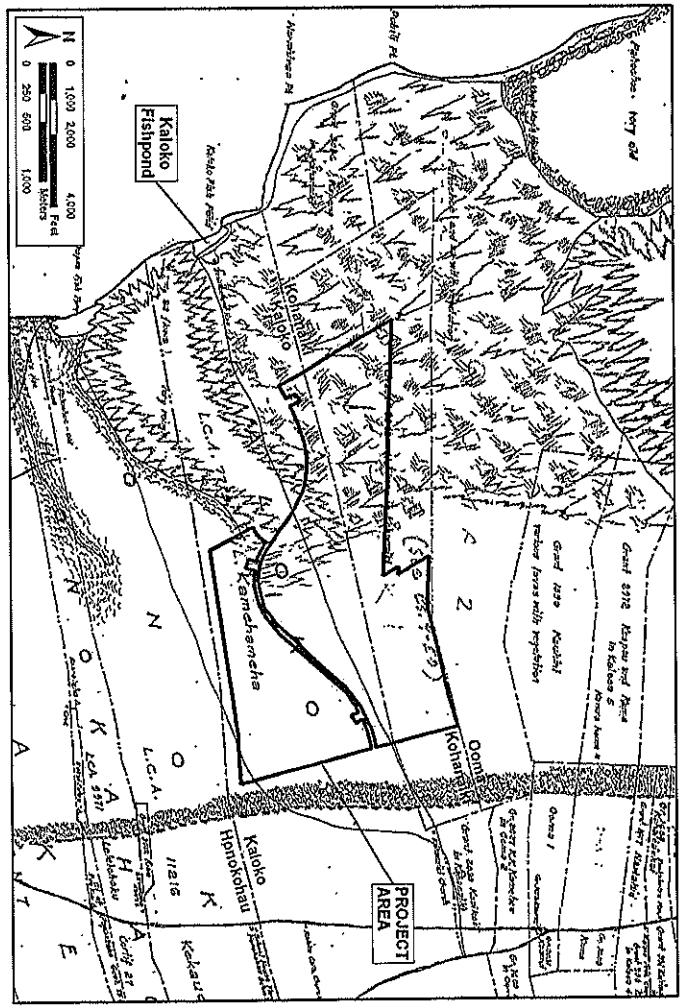

Figure 1. Portion of Emerson's Registered Map (RM) 1280, showing approximate location of project area. The location of "Kohanaiki Church" and Kaloko Fishpond are also shown.

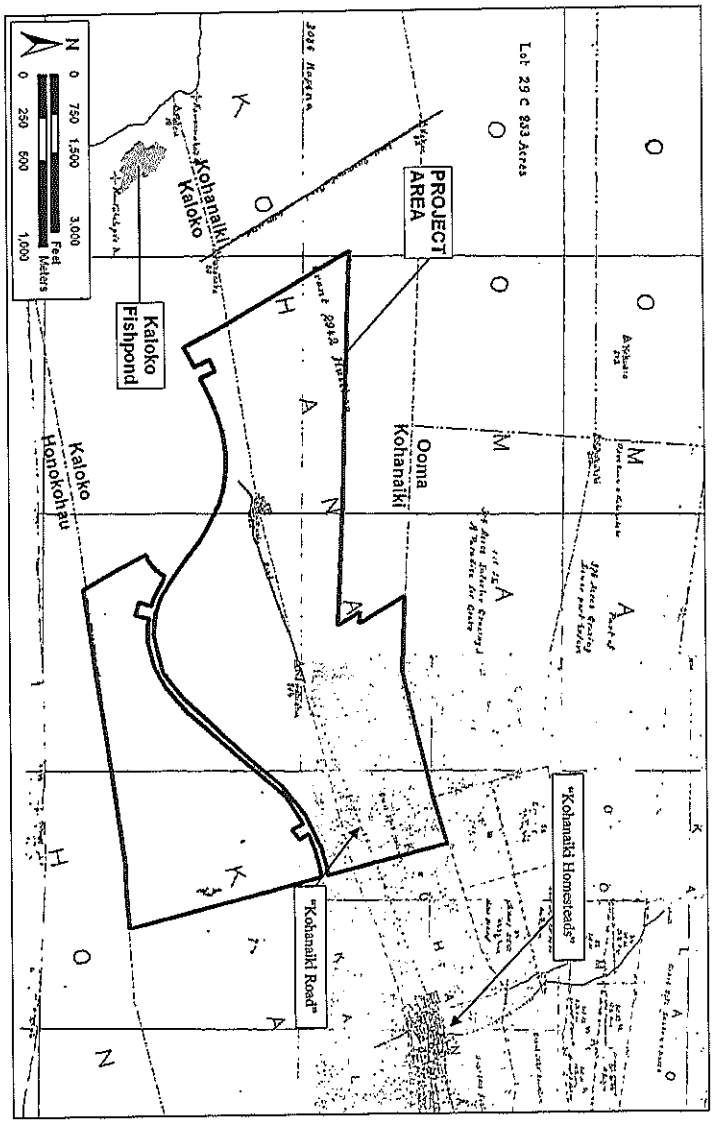

Figure 2. Portion of Emerson's Registered Map (RM) 1449 and 1512, showing project area and "Kohanaiki Road" leading from the Kohanaiki Homesteads to Kaloko Fishpond.

> what the ancient people of Kekaha wai 'ole believed, and there were people who were *kia'i* (guardians) who watched over and cleaned the caves, the house of Kāne... [*Ka Hoku o Hawaii*, September 24, 1929:3].

Kaloko and most of Kohanaiki continued to be held by the *ali'i* throughout the remainder of the 19th century, passing, after the death of Lot Kamehameha, successively to Bernice Pauahi Bishop, Kalākaua and Kapi'olani.

Oral history interviews (Maly and Maly 2003) relate that in the mid 1800s only a few residences were on the coastal lands, in the uplands above 900 ft. elevation, and in the vicinity of Māmalahoa Highway (east of the project area). The land between 900 ft. and the coast was cattle, donkey, and goat pasturage. *Mauka/makai* trails through Kohanaiki, Kaloko, Kalaoa, and Honokōhau were utilized by upland families to access the coast to fish, and gather water during upland droughts.

1900s

During the 20th century, major developments focused on Kaloko Ahupua'a, with continuing commercial use of the fishpond and increasing animal husbandry. The Kohanaiki Homesteads were apparently in decline during the early part of the century (Maly and Maly 2003), and are mentioned only in passing in H.W. Kinney's 1913 visitor's guide, which notes that it is an "inland settlement without much interest".

Ranching, however, steadily increased. Once John Maguire purchased the former chiefly lands of Kaloko in 1906 (after the deaths of Kalakaua and Kapiolani; Kelly 1971:29), the *ahupua'a* uplands were developed into the Huehue Ranch. Maly and Maly (2003) discuss the acquisition of these lands and the types of ranching that were common:

> In 1899, John A. Maguire, founder of Huehue Ranch applied for a Patent Grant on... lots in 'O'oma 2nd, but he only secured Grant No. 4536.... Maguire's Huehue Ranch did secure General Lease No.'s 1001 and 590 for grazing purposes on the remaining government lands in the Kohanaiki and 'O'oma vicinity. Thus, by the turn of the century, Huehue Ranch, utilized both the upper forest lands and lower kula lands to the shore for ranching purposes. Oral history interviews with elder former ranch hands record that this use extended across the Kapena and Huliko'a grant lands of Kohanaiki, from the fee and leasehold lands of Kaloko and 'O'oma. Nineteenth century goat drives, gave way to formalized cattle drives and round ups on these lands [Maly and Maly 2003:78].

Until the construction of the Queen Ka'ahumanu Highway in the 1970s, access to the "kula kai (shoreward plains)" (Maly and Maly 2003:101) was limited to local residents. The 1924 USGS map (Figure 3) shows "the road to the sea" connecting the Kohanaiki Homesteads with the Kaloko fishpond, and crossing the project area at the *ahupua'a* boundary between Kohanaiki and Kaloko. In the first half of the 20th century, the primary method of travel was "by foot or on horse or donkey, and those who traveled the land, were almost always native residents of Kalaoa, 'O'oma, Kohanaiki, Kaloko and Honokōhau" (Maly and Maly 2003:99). Huehue Ranch bulldozed a jeep road to the shore around 1955 (Figure 4) during the construction of the Kailua pier, and this was used primarily by the ranch employees for duties or for going fishing along the coast.

The Kaloko fishpond - leased from the Huehue ranch - continued as a commercial fishing operation until the 1950s. During the 1970s, the pond was incorporated into the newly-established Kaloko-Honokōhau National Historic Park.

Modern Land Use

While the present project area is largely undeveloped, surrounding areas have seen increasing modern use. The Huehue Ranch jeep road and other signs of animal husbandry activity can be seen on the 1959 USGS map (Figure 4). More recent nearby development is largely industrial, and the Kaloko Industrial Area is just southwest of the project area, including large stores such as Home Depot and Cosco. Hulikoʻa Road, just northwest of the project area, is also heavily developed, primarily as an industrial area. Hina-Lani Street runs through the central portion of the project area, and leads *mauka* to a residential area (Kona Heavens) before the Palani Road junction (at Māmalahoa Highway), as well as leading *makai* to the modern Queen Kaʻahumanu Highway. Bulldozing and modern trash are present in some portions of the project area, primarily on the Kaloko Ahupuaʻa side; some of this area has been used by squatters for campsites, leaving a variety of trash and furniture. However, the majority of this disturbance is near Hina Lani Street, and most of the project area shows little sign of modern intrusion.

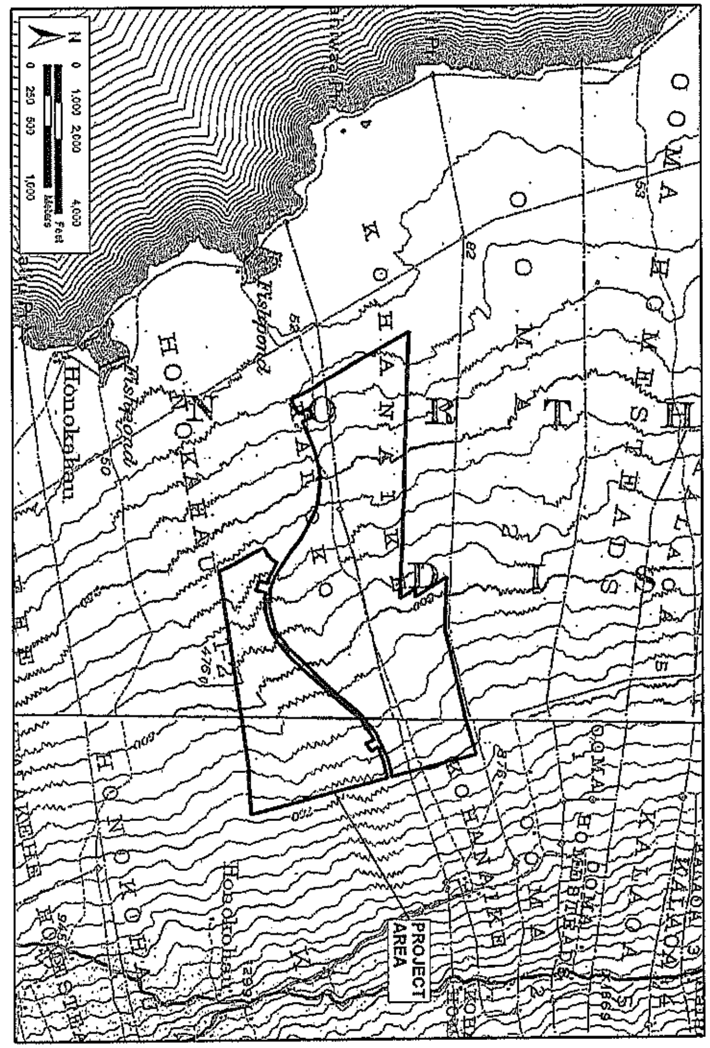

Figure 3. Portion of 1924 USGS map, Keahole Point and Kailua quadrangles, with overlay of project area

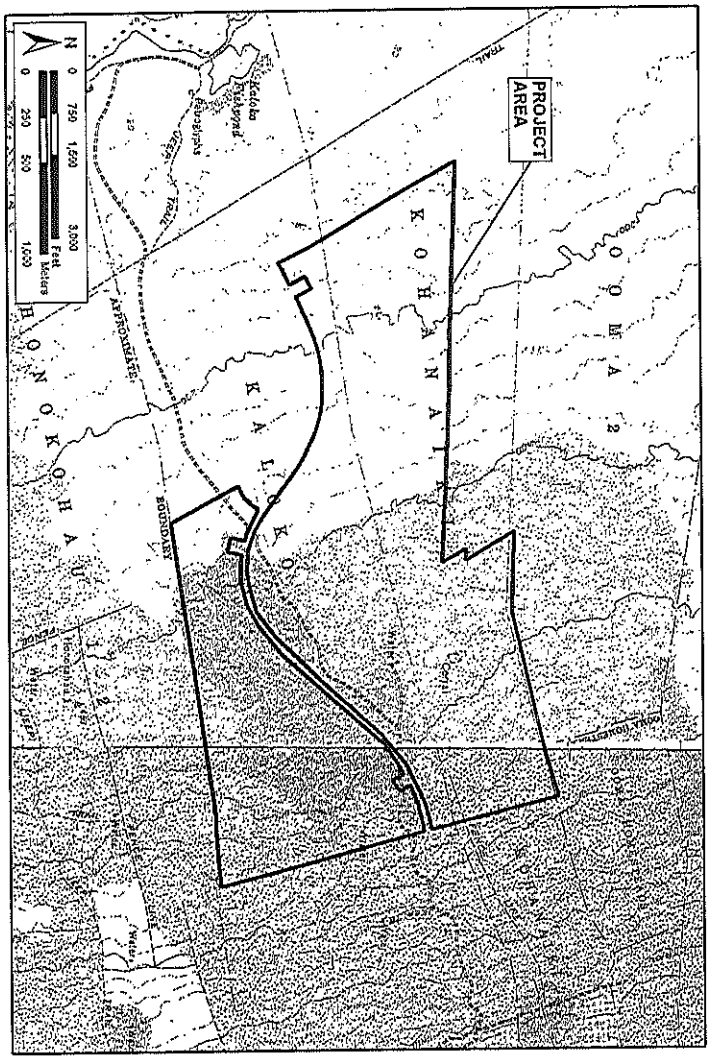

Figure 4. Portion of 1959 USGS map, Keahole Point quadrangle, with overlay of project area showing jeep road and signs of historic/modern animal husbandry

Previous Archaeological Research

Overview of Archaeological Studies Conducted within Kohanaiki and Kaloko

This section provides a synopsis of archaeological studies in Kaloko and Kohanaiki *ahupua'a* (Figure 5). Table 1 lists archaeological studies in this area with brief comments; studies most relevant to the current project are discussed in additional detail in the text. Studies previously conducted within the project area are highlighted within Table 1 in bold.

Previous archaeological surveys conducted within portions of Kohanaiki and Kaloko *ahupua'a* began with the early coastal survey conducted by John Reinecke for the Bernice P. Bishop Museum in 1929-1930 (Reinecke 1930). This was a cursory survey in which approximate site locations and very brief site descriptions were recorded. John Reinecke (1930) recorded eight sites at the coast of Kohanaiki; the sites - minimally documented and mapped - included habitation sites and a *heiau*. The next survey was undertaken by Kenneth Emory and Lloyd Soehren in 1961 (Emory and Soehren 1971). This was also a coastal survey, and focused specifically upon the coast of Kaloko, Honokohau, and Kealakehe. In 1970 and 1971, Robert Renger and students from the University of California at Santa Barbara conducted an intensive survey of Kaloko and Honōkohau between present day Queen Ka'ahumanu Highway and the coast (Cordy et al. 1991). This survey also included subsurface testing of selected sites. These three surveys identified a total of 94 sites within Kaloko between the coast and Queen Ka'ahumanu Highway as of 1971.

Survey work was undertaken in 1970-71 by Renger inland of the highway - i.e. that middle zone of Kaloko that includes a portion of the present study area. Although the findings of much of this fieldwork within the middle zone were written up in detail (Cordy et al. 1991), the findings from the survey sample conducted specifically within the project area (i.e. that portion of the middle zone situated on the inland side of the Queen Ka'ahumanu Highway) were not included because, "regrettably... it appears that the maps and survey records have been misplaced since the end of the 1971 field season" (Cordy et al. 1991:340). Renger's summary of the findings from that part of the survey indicated that fifteen features were identified:

> Very few sites were discovered within the "transitional middle zone" ... between the coastal and upland exploitation zones ...Seven lava tube shelters, four trails (coast-upland), three platforms, two cairns ... two low-walled enclosures, and an L-shaped structure were recorded. (cited in Cordy et al. 1991:340)

These sites are presumably the subject of a set of Renger's (1971) "Kaloko Field Notes" that begins "*Mauka* Excavations" but in the apparent absence of any site location map it is difficult to relate these notes to specific sites in the field.

It is our understanding that Lloyd Soehren (1979) conducted a reconnaissance survey of the Kaloko access road corridor, understood as the present alignment of present Hina-Lani Street, but identified no sites.

Additional archaeological work and historical research undertaken within or about Kaloko during the 1970s and 1980s include: an historical study by Marion Kelly (Kelly 1971); research relating to the establishment of the Kaloko-Honokohau National Park (e.g. Honokohau Study Advisory Commission 1974, National Park Service 1975); and several reconnaissance-level studies (Ching 1980, Hammatt 1980, Soehren 1983).

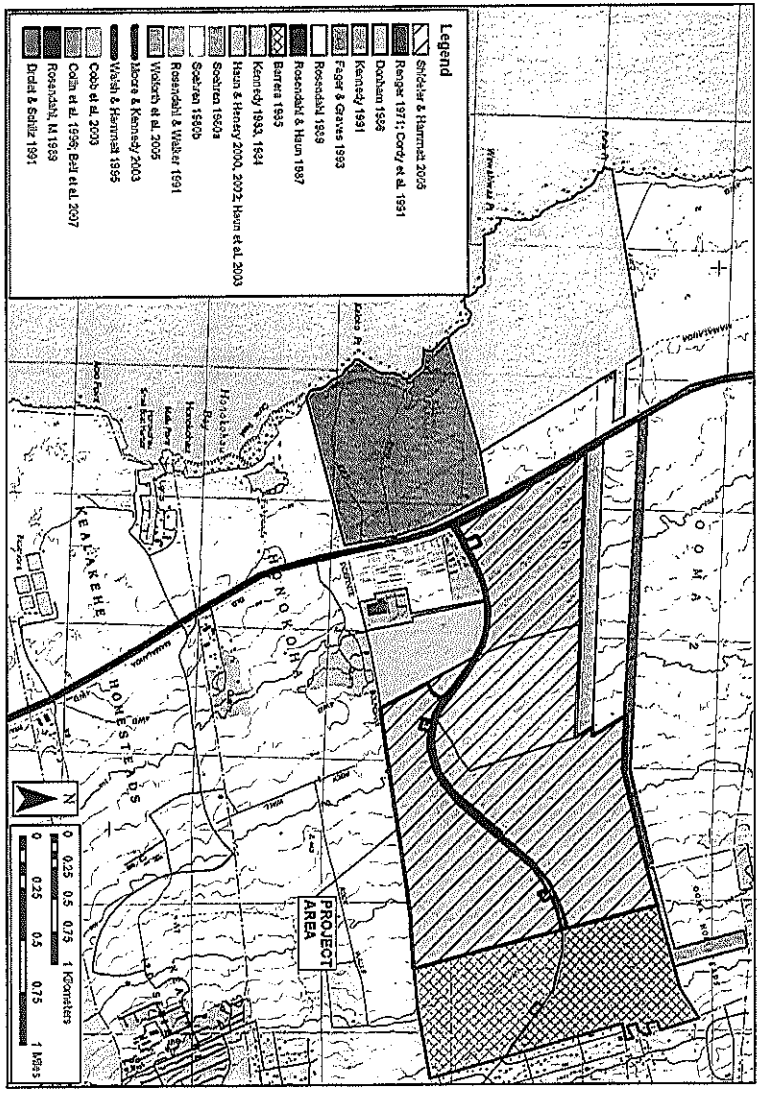

Figure 5. Previous archaeological studies in the vicinity of the project area

Table 1. Previous Archaeological Studies Within Kohanaiki and Kaloko *ahupua'a* (projects in present study area are in bold)

Source	Nature of Study	Area of Study	Finds	Comments
Reinecke 1930	Cursory survey	Coastal Survey	Briefly notes numerous sites	All sites *makai* of present project area
Emory & Soehren 1971	Cursory survey	Coastal Survey	Briefly notes numerous sites	All sites *makai* of present project area
Kelly 1971	Historical survey and background	Kaloko and Kuki'o *ahupua'a*	Background study	Good background study
Renger 1971	**"Field Notes" of "*Mauka* excavations"**	**"*Mauka* excavations"**	**"Field Notes" describe several sites**	**No site location map thus hard to be sure where sites are**
Soehren 1979	**Letter Report Reconnaissance Survey**	**Kaloko Access Road Corridor (Hina-Lani Street)**	**No finds**	**Letter Report not actually seen**
Soehren 1980a	Letter Report Reconnaissance Survey	Kaloko lowlands	No finds	Letter Report not actually seen
Soehren 1980b	Letter Report Reconnaissance Survey	Kaloko Access Road Corridor	Discusses 3 stepping stone trails, 2 *ahu* & a lava tube complex	Hina-Lani Street Letter Report not actually seen
Hammatt (ARCH) 1980	Archaeological Reconnaissance	410 acre parcel	Identified 2 sites	*Mauka* of present project area
Barrera Jr. 1983	Archaeological Reconnaissance	TMK 7-3-9:19	No finds	No map
Soehren 1983	Archaeological Reconnaissance Letter Report	-	-	Not seen
Kennedy 1983	**Archaeological Reconnaissance**	***Makai* of present project area**	**Identifies 27 sites**	**Within present project area**
Kennedy 1984	**Intensive Archaeological Survey**	***Makai* of present project area**	**Results of investigations of 25 sites**	**Within present project area**
Barrera Jr. 1985	Archaeological Survey	409 acres 700 to 1080' elevation	58 sites	*Mauka* of present project area

Source	Nature of Study	Area of Study	Finds	Comments
Donham 1986	Archaeological Reconnaissance Survey	470-acres *makai* of Queen K Hwy	105 sites	Kohana-iki development
Rosendahl & Haun 1987	**Archaeological Reconnaissance Survey**	**3 1-acre parcels**	**Their project area *mauka* of present project area had one site**	**Water tanks along Hina-Lani Street**
Barrera Jr. 1988	Archaeological Excavations	YO Project Area	60 sites	Report not actually seen
Rosendahl, M 1989	Archaeological Inventory Survey	200 ft.-wide corridor along boundary separating O'oma 2 and Kohanaiki	Identified 4 sites; site 5699 extends into current project area	Adjacent to and north of present project area
Rosendahl 1989a	**Letter Report Addendum to Archaeological Inventory Survey**	**Addl info re: site 13493 stepping stone trail by *makai* tank**	**Identified one *pāhoehoe* slab trail (site 13493)**	**Water tank *makai* end of present project area**
Rosendahl 1989b	Field Inspection	Kaloko Mauka Parcel # 1	Identified 4 sites	Report not actually seen
Rosendahl 1989c	Field Inspection	Kaloko Mauka Parcel # 2	No sites identified	Report not actually seen
Rosendahl & Walker 1990	**Addendum to Archaeological Inventory Survey**	**Addl info re: site 13493 trail by *makai* tank**	**Addl info re: site 13493 trail by *makai* tank**	**Water tank *makai* end of present project area**
Rosendahl & Walker 1991	**Archaeological Field Inspection**	**Industrial crusher site, 2 adjacent 10 acre parcels**	**Identified a trail with two cairns**	**Within present project area**
Barrera Jr. 1991	Archaeological Inventory Survey & Data Recovery Report	800 to 1100'	Identified 61 sites	*Mauka* of present project area
Cordy et al 1991	An Ahupua'a Study: The 1971 Archaeological Work at Kaloko	Kaloko-Honokōhau National Park	76 sites identified, 20 sites relocated	*Makai* of present project area
Kennedy 1991	Surface Reconnaissance	Long thin industrial development	No significant finds	North of present project area

Source	Nature of Study	Area of Study	Finds	Comments
Drolet & Schilz 1991	Archaeological Inventory Survey	8.8 acres in O'oma 2	29 sites identified; **Site - 16103 extends into project area**	Adjacent to and north of present project area
Barrera Jr. 1993	Archaeological Inventory Survey	5.7 acres; 1450 to 1630' elevation	Identified 40 features of Kona Field System	*Mauka* of present project area
Fager & Graves 1993	Archaeological Inventory Survey	Kaloko Industrial Park parcel	Identified 17 sites with 60 component features	*Makai* of present project area, south of Hina-Lani Street
Fager & Rosendahl 1993	Interim Report Archaeological Inventory Survey	Kaloko Industrial Park parcel; 15+ acres	Identified 17 sites with 60 component features	*Makai* of present project area, south of Hina-Lani Street
Henry & Graves 1993	Archaeological Inventory Survey	Transmission line project *mauka* side of Queen K Hwy.	Identified 8 sites *makai* of project area	*Makai* of present project area
O'Hare & Rosendahl 1993	Report on burials	On coast	Report on burials	Kohana-iki Resort project
Rosendahl 1993	Archaeological Field Inspection	Kaloko Mauka Parcel	4 sites discussed	Report not actually seen
Nees & Williams 1995	Archaeological Investigations	110 acres, 2100 to 2900' elevation	Identified enclosure, lava tube, terrace, wall, mounds	*Mauka* of Present Project Area
Walsh & Hammatt 1995	Archaeological Inventory Survey	Queen K Hwy Right-of-Way	Identified 9 sites adjacent to *makai* side of Hwy in Kohanaiki & Kaloko	*Makai* of Present Project Area
Colin et al. 1996	**Archaeological Inventory Survey**	**224 acres *makai* of present project area**	**Identified 55 sites**	**Within present project area**
Rechtman 1998	**Archaeological Field Inspection**	**2400-2500' elevation**	**No finds**	***Mauka* of Present Project Area**
Rechtman & Henry 1999	**Archaeological Inventory Survey**	**1450-1620' elevation**	**Identified 15 sites**	***Mauka* of Present Project Area**

Source	Nature of Study	Area of Study	Finds	Comments
Wolforth 1999	Monitoring Report	HELCO Keāhole-Kailua Transmission line corridor	Describes one site 21258	Says Walsh & Hammatt previously id'd site as 19946 (on *makai* side of hwy)
Haun & Henry 2000	Archaeological Inventory Survey	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre parcel	45 sites with 81 features	*Makai* of present project area south of Hina-Lani Street
Rosendahl 2000	Archaeological Assessment	2435-2730' elevation	No finds	*Mauka* of Present Project Area
Clark & Rechtman 2002	Archaeological Inventory Survey	1200' to 1600' elevation	Identified 5 sites	*Mauka* of Present Project Area
Haun & Henry 2002	Data Recovery Plan	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre	Data Recovery Plan addresses 8 specific sites	*Makai* of present project area south of Hina-Lani Street
Rechtman & Rivera 2002	Archaeological Assessment	3-7-3-26:4; 3,100'	No finds	*Mauka* of Present Project Area
Cobb, Elmore, and Kennedy 2003	**Archaeological Assessment**	**TMK: 7-3-09:25, 26 & 28 at Kaloko and Kohanaiki (400 acres)**	**Briefly identifies 154 features, within present project area**	**Descriptions quite brief; map hard to correlate with sites found in present survey**
Haun 2003	**Archaeological Assessment**	**400-Acre Portion of TMK 7-3-09:28 Kaloko**	**Identifies 8 sites (63 features) north of present project area**	**Helicopter flight overhead led him to focus on open *'a'ā* area**
Haun et al. 2003	Data Recovery Report	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre	Data Recovery Report addresses 8 specific sites	*Makai* of present project area south of Hina-Lani Street
Moore & Kennedy 2003	**Archaeological Inventory Survey**	**Roadway Corridor**	**Identified 1 site (23973) 2 mounds**	**Runs through center of project area**
Puette & Dye 2003	Archaeological Inventory Survey	22 acres 2100 to 2400' elevation	No finds	*Mauka* of Present Project Area

Source	Nature of Study	Area of Study	Finds	Comments
Rechtman 2003	Archaeological Assessment	3-7-3-26:5; 3,1000' elevation	No finds	*Mauka* of Present Project Area
Elmore et al. 2004	Archaeological Inventory Survey	1400' elevation	Identified one historic site 24133	*Mauka* of present project area
Shideler, and Hammatt 2005	**Archaeological Field Inspection and Literature Review**	**1,200+ Acres in Kaloko and Kohanaiki**	**Numerous pre-contact sites observed, including: habitations, agricultural features, petroglyphs, boundary walls, and burials**	**Within present project area**
Wolforth et al. 2005	Archaeological Inventory Survey	TMK: [3] 7-3-09: 032	A total of 89 sites were identified, consisting of burials, perm. habitation, temp. habitations, religious sites, trails, boundary walls, and agricultural sites	Immediately *mauka* of present project area
Nelson et al. 2006 (currently under review by SHPD)	Archaeological Inventory Survey	TMK:3-7-3-009:007	**Identified site -16103, which extends into project area**	Adjacent to and north of present project area; **one site extends into project area**

During the 1980s, PHRI began investigations of the entire *makai* portion of Kohanaiki Ahupua'a, bounded by its boundaries with 'O'oma 2 and Kaloko, and by the Pacific Ocean and the Māmalahoa Trail. During an inventory survey in 1986 (Donham 1986), "14 previously recorded sites were relocated and 91 sites were newly identified...Habitation sites represented over half of the identified site total, and included habitation complexes, habitation/ceremonial and/or habitation/burial complexes, and temporary habitation sites" (Donham 1986:7-8). In 1991, PHRI performed data recovery of the project area (O'Hare and Goodfellow 1992); this work included: "detailed recording of (a) 31 sites (224 features) previously recorded in the project area, and (b) seven sites newly recorded during the Phase II work" (O'Hare and Goodfellow 1992:ii). Summarizing Kohanaiki settlement pattern within the zones represented by the project area, the report notes:

> The data recovery work indicates that permanent habitation sites between Puhili and Wawahiwaa Points are concentrated in the coastal zone, near the shoreline. In the coastal area south of Wawahiwaa Point permanent habitation sites were near the shoreline and further inland. Temporary habitation sites were present in all areas of the coastal zone and in the barren rockland zones. The radiocarbon date ranges indicate that sites in the northern coastal zone might have been inhabited as early as AD 1020. Sites in the southern coastal zone may have been inhabited as early as AD 1370, and sites in the barren rockland zones may have been inhabited as early as AD 1180. In the barren rockland zones, use of the sites was terminated before the historic period, and in the coastal zone most of the sites were not used in the historic period [O'Hare and Goodfellow 1992:ii].

Cordy (1981) conducted a survey of the coastal area (up to 1/2 mile inland) of Kohanaiki in 1975; twelve sites were recorded including: pavings, platforms, enclosures and a trail. Eleven of the sites were interpreted as habitation constructs including sleeping houses, men's houses, special purpose, and a canoe house/men's house.

In 1983 Joseph Kennedy conducted a reconnaissance and subsequent intensive survey (1984) of a parcel that is within the present project area. The 1983 reconnaissance located and briefly described twenty-seven sites. These sites included 17 lava tubes, 3 *ahu* or cairns, 2 walls, 2 platforms, an enclosure, a modified outcrop, and a trail. The 1984 intensive survey identified:

> 45 separate cave openings and approximately 200 chambers in these caves. In addition there were 4 walls recorded, 5 enclosures, 13 platforms, 9 *ahu*, 2 trails and 2 sets of petroglyphs. Out of the 79 separate features on the property, 30 were judged to be worthy of re-investigation ... the remaining 49 sites that were not reinvestigated were comprised almost exclusively of relatively shallow caves with little or no evidence of cultural remains or associated modifications [Kennedy 1984:18].

Many (but not all) of the sites identified in 1984 are described and some of these sites were not mapped. Excavations were carried out in three caves (Sites 11, 22 and 49 in the Kennedy 1984 numbering system). Of the twenty-five sites for which information is presented in the Kennedy 1984 study, twenty-two sites are recommended for no further work and three (Kennedy 1984 site #s 11, 22 & 32) are recommended for preservation.

In 1985, Barrera (1985) surveyed approximately 409 acres within Kaloko and Kohanaiki *ahupua'a*; the 409-acre parcel is located between Māmalahoa Highway and Queen Ka'ahumanu

Highway, just *mauka* of the present project area. Four sites were recorded in Kaloko, including an enclosure, a lava tube cave, a wall and a platform (possible burial). Fifty-five sites were recorded within Kohanaiki and include mounds, platforms, habitation complexes, walls, and terraces. A portion of the study area included the historic period Kohanaiki Homestead. Barrera's site #59 comprises constructions associated with the homestead and is described as a "series of Habitation areas enclosed by large stone walls." No estimate is given of the ages of the other fifty-eight sites.

In 1987, Paul H. Rosendahl Inc. accomplished an archaeological reconnaissance survey of three one-acre parcels - proposed water tank sites - in Kaloko (TMK: 7-3-09:Por.1,17) (Rosendahl and Haun 1987), along the south side of the then "main access road between Queen Ka'ahumanu Highway and Kona Heavens Subdivision" - i.e. the present Hina-Lani Street. The parcels were located at 350 ft. above mean sea level (A.M.S.L.), 630 ft. A.M.S.L., and 910 ft. A.M.S.L. Only one site (State site 10-28-10887) - an historic wall interpreted as a boundary or cattle wall - was recorded within the *mauka*-most parcel. Subsequently, in 1989, an additional water tank site parcel (TMK: 3-7-3-10:Por.17) - measuring 360 ft. north/south and east/west - was subject of an archaeological inventory survey (Rosendahl 1989). The parcel bordered the north side of the then "proposed Kamanu Street extension in the Kaloko Light Industrial Park" at the south boundary along Hina-Lani Road. One site was recorded and designated state site 50-10-27-13493:

> a steppingstone trail segment measuring 7.5 m (24.6 ft.) long (E-W) by 0.6-0.7 m wide (1.97-2.30 ft.) (N-S)...located on a section of aa lava...The segment consists of approximately six flat and roughly round pahoehoe slab steppingstones set on worn aa gravel. The steppingstones measure c. 0.4 m (1.31 ft.) in diameter by 0.1 m (0.33 ft.) thick. The trail is oriented c. 159 degrees Az. (magnetic). No portable remains were present in association with the trail. The trail appears to be prehistoric, and appears to have been used as a secondary transportation route [Rosendahl 1989:1].

In 1988, Cordy et al. (1991) began preparing a study of Kaloko *ahupua'a* for the new Kaloko-Honokōhau National Park. The study was based on Renger's 1971 fieldwork conducted for planned development of coastal Kaloko for Huehue Ranch. The fieldwork "included survey work in the intermediate and upland zones of Kaloko, which located additional sites, extensive excavation in the coastal area, and some excavation in the intermediate and upland sites" (Cordy et al. 1991:2). Renger identified, and in some cases re-identified, 94 sites that included 59 in the Coastal Zone, 30 in the Middle Zone, and five *mauka/makai* trails that crossed both zones and continued heading inland. As only "summary papers" had been previously written, the monograph published in 1991 includes the 1971 fieldwork data and resultant analyses, plus fieldwork conducted by Cordy and Hitchcock in the 1970s and 1980s (Cordy et al. 1991:2, 44).

In 1989 Margaret Rosendahl conducted an archaeological inventory survey of a 200 ft.-wide corridor along the boundary separating O'oma 2 and Kohanaiki, north of the project area, for a water system. Survey results included the identification of four sites that included quarrying pits, a ceremonial/habitation complex, a marker, and a historic wall. The wall, Site -5699, ran along "the inland boundary of the survey corridor" (Rosendahl, M 1989:13). During the current survey, 15 m of the wall's south end extends within the project area, and continues roughly north for at least 500 m. The rubble-fill method of construction indicates the wall is historic. No further work was originally recommended, although possible inclusion into landscaping was suggested for consideration (Rosendahl 1989:14).

In 1991, Archaeological Consultants of Hawaii (Kennedy 1991) performed a reconnaissance survey of a narrow corridor - 500 ft. north/south by 7260 ft. *mauka/makai* (TMK: 7-3-09:15) - in Kohanaiki extending *mauka* from Queen Ka'ahumanu Highway, located adjacent to the southern boundary of the present study area. No sites or features were observed; seven caves "were examined to term and were determined to be devoid of cultural materials" (Kennedy 1991:C-1).

In 1991 William Barrera produced an archaeological inventory survey and data recovery report of an extensive area just inland (*mauka*/east) of the present study area in which he identified 61 sites. These sites were rather clumped in the east central portion of his project area.

In 1991 Drolet and Schilz conducted an archaeological inventory survey of 8.8 acres in O'oma 2, north of and adjacent to the current project area. Survey findings included the identification of 29 sites including two cave complexes, site -16103 and -16104, that extend into the current project area. Nelson et al. (2006:66) found that the two caves connect and actually consist of one subsurface complex. They referred to the sites as -16103. Drolet and Schilz (1991:27-28) determined that the sites were significant and their project, as planned, would avoid the sites and provide a "10 meter buffer zone" around them. Nelson et al. (2006:66) describe the site as contaning "several architectural modifications, a plethora of cultural debris, and a single human burial." They determined that "site 16103 retains integrity of location and is in good condition for an archaeological ruin" (Nelson et al 2006:66). CSH only had access to this particular site description since the report is currently under review by SHPD.

Rosendahl and Walker (1991) carried out an Archaeological Field Inspection for proposed Kaloko Industrial crusher sites just south of Hina Lani Street at an elevation of approximately 450 ft. a.m.s.l. A trail and two associated cairns were identified.

In 1993, Paul H. Rosendahl Inc. conducted an inventory survey (Fager and Graves 1993) of an approximately 15-acre parcel adjacent to, and *mauka* of the Kaloko Industrial Park, which includes a road corridor extended from the main project area to Kamanu Street. The survey recorded 17 sites incorporating 60 component features. The sites were judged

> ...in poor to good condition and comprised the following formal types: terraces, modified outcrops, mounds, walls, caves, pahoehoe excavations, cairns, filled cracks, enclosures, and a trail. The formal types comprised the following functional types: animal husbandry, temporary habitation, agriculture, marker, quarry, and transportation [Fager and Graves 1993:ii].

In 1995, Cultural Surveys Hawai'i conducted an archaeological inventory survey with limited subsurface testing within a narrow strip of land, averaging 300 ft wide, along Queen Ka'ahumanu Highway between Palani Road and the Keāhole Airport entrance road (Walsh and Hammatt 1995). Three sites were identified in Kohanaiki: two trails and a set of three cairns. One of the trails - a *mauka-makai* trail - had been previously identified and designated Site 50-10-27-15324. The site is described as consisting of:

> ...two converging trail segments designated Features A and B...Both trail segments extend in a roughly mauka-makai direction, but angle toward each other and converge into one trail that continues inland. The point where the two trails meet is located at the edge of the bulldozed portion of the present highway right of way, 164 feet (50 m.) from the makai edge of the highway pavement...On the mauka side of the highway, the trail was observed at the edge of the bulldozed portion of the

> powerline (the new right-of-way boundary) and continuing inland at 65 degrees T.N. for at least another 100 feet (30 m.) [Walsh and Hammatt 1995:51].

In 1996, Cultural Surveys Hawai'i conducted an archaeological inventory survey (Colin et al. 1996) with limited subsurface testing within a 224.43-acre project site (TMK [3] 7-3-09: 017) for Kimura International. Fifty-five (55) sites were identified within the project area. All identified sites were of pre-Contact traditional Hawaiian origin and included the following site types: *ahu* (rock cairn) simple agricultural features, recurrent and temporary habitation sites, trails, enclosures, walls, and a quarry. The Colin et al. 1996 report was reviewed by the State Historic Preservation Division twice (8/15/1996 and 4/7/1997), however, during the review process the project was terminated; project funding stopped and final revisions to the report were not completed. Thus the Colin et al. report (1996) was never accepted by SHPD. An update for this report is currently in the process of being re-submitted to SHPD after recent re-survey; this updated reported comprises the TMK 17 portion of the current CSH Kaloko Makai (Kohan 1) project.

A series of studies (Haun & Henry 2000, 2002, Haun et al. 2003) were carried out on a 102-acre Kaloko Industrial Park parcel *makai* of the present project area on the south side of Hina-Lani Street. Of note is the fairly dense and widely distributed site concentration and also extensive areas of both *'a'ā* flow and bulldozing that are shown as widening as they approach the present study area adjacent to the east. Also of note is the jeep road in their project area labeled "Huehue Ranch Road", which continues into the current project area. This is likely the road that was cut around 1955 by Huehue Ranch during construction of the Kailua pier.

In recent years a number of studies have been undertaken in the Kaloko Mauka lands (east and upslope from the present project area) including studies by Barrera Jr. (1993), Nees & Williams (1995), Rechtman (1998), Rechtman and Henry (1999), Rosendahl (2000), Clark & Rechtman (2002), Rechtman and Rivera (2002), Puette & Dye (2003), Rechtman (2003), and Elmore et al. (2004).

In 2003, Archaeological Consultants of the Pacific, Inc. (Cobb et al. 2003) conducted an archaeological assessment of TMK (3) 7-3-009: 025, 026, and 028. One hundred fifty-four (154) features were identified and included "caves, walls, mounds, platforms, enclosures, trails, *cairn*, "C"-shaped structures, possible *heiau*, terraces, alignments and modified outcrops" (Cobb et al. 2003:1). Each feature was identified with a number prefaced with "TF", and descriptions included feature type, a brief description, possible function and a preliminary significance evaluation. The report map does not show the location of particular sites found during the survey but has colored points for sites indicating "High Concern, Potential High Concern, and Minimal Concern" (Cobb et al. 2003:5). The current project area was included in the survey and several site tags from the 2003 survey were found in sites recorded during the current project.

Haun (2003) also did an archaeological assessment of a portion of the current project area, largely via helicopter to cover the *'a'ā* terrain, but also by foot in the thicker vegetation. He identified eight sites, all of which correlate to sites documented in the current Kaloko Makai inventory survey report for TMK 28.

In 2005 Wolforth et al. conducted an archaeological inventory survey of the northern portion of the Kaloko Heights Project (TMK [3] 7-3-09: 032), located immediately east of the current project area. A total of 89 sites were identified, consisting of burials, permanent habitations, temporary habitations, religious sites, trails, boundary walls, and agricultural sites. A historic

wall that runs along the *ahupua'a* boundary between Kaloko and Kohanaiki extends from TMK 32 into TMK 25.

In 2005 CSH completed an archaeological field inspection of a 1200+ acre project area in Kaloko and Kohanaiki [TMK (3) 7-3-009:017, 025, 026, and 028] that included the current project area. Numerous pre-contact sites including, habitations, agricultural features, petroglyphs, boundary walls, and burials were observed (Shideler & Hammatt 2005).

RESULTS OF ARCHAEOLOGICAL INVENTORY SURVEY

A total of 341 archaeological sites were identified in the course of the archaeological inventory survey work (59 sites in TMK 17, 121 sites in TMK 25, 120 sites in TMK 26 and 41sites in TMK 28; see Figure 6). Site density for each parcel by acre is summarized in Table 2. Summaries of these sites are presented for each tax map key parcel in the following Table 3 through Table 8. An overview of the formal feature types, functional categories, and significance criteria is presented below followed by a summary discussion of the finds.

Table 2. Site density by parcel and acreage

	Acreage	# of Sites	Sites/Acre
TMK 17	224.43	59	0.26
TMK 25	360.131	121	0.34
TMK 26	194.324	120	0.62
TMK 28	363.106	41	0.11
Total	**1141.991**	**341**	**0.33**

Formal Feature Types

Formal feature type designations are descriptive - based on physical characteristics - and commonly refer to structural elements of a site. Fifteen primary feature types were identified within the project area. The following are brief descriptions of the different feature types encountered during the inventory survey:

Alignment: A single row of stones one courses high.
Cairn: A marker of stacked or piled stones. Cairns are frequently referred to as *ahu*.
Enclosure: A walled structure that completely encloses an area.
Lava blister: A small subterranean lava formation. Unlike lava tubes, however, they tend to be circular and do not extend in any direction for a great length.
Lava tube: Modifications or apparent usage of a subterranean lava formation characteristic of *pāhoehoe* lava flows.
Modified depression: An area in which stones have been removed to create a depression or to expose a soil area. Two types of modified depressions were encountered, one type (encountered on a lava flow) appears to have functioned as a storage area and the second type in which the only modification consists of the removal of stones to create an area suitable for agriculture either in soil or possibly through mulching.
Modified outcrop: An area within an existing lava flow in which a portion of the flow has been humanly modified by the placement or removal of stones (a modified tumulus differs from a modified outcrop in that a modified tumulus is in a field of exposed outcrop whereas a modified outcrop may be surrounded by soil).
Mound: Linear, circular or amorphous stone pile which typically lacks a vertical face and level surface.
Pavement: A stone-filled floor or surface.
Platform: A raised free-standing stone structure with three or more vertical faces.

Rock art: A carving or inscription on a boulder, cobble, or slab.
Terrace: A raised stone construction partially built against, or level to, a ground or outcrop surface. These structures commonly resemble platforms. Unlike platforms, however, they are not totally free-standing.
Trail: A trodden lava surface, pavement or stone alignment set into the ground or outcrop surface.
Wall: A bi-faced and free-standing stone structure which is an isolated segment or defines large boundaries.

Function Interpretation

Function interpretation of a site or feature is determined by criteria which included: site construction and complexity; locational context (association with other sites and/or geological determinates); analysis of cultural remains (surface and subsurface); and external correlations with other archaeological sites in Hawai'i. Ten primary function categories were identified among the sites within the project area: agriculture; animal husbandry; habitation; human burial, ceremonial; indeterminate; marker; mining (quarrying) and storage (activity areas); rock art, transportation; and water collection (activity area). The following are brief descriptions of the different function types commonly encountered in this general area:

Activity area: The feature represents the extent of space serving a special function, or the scope of a specific activity; this category may include lithic production, water collection, storage, fishhook manufacture, quarrying or mining, etc.
Agriculture: Primary function is for farming, horticulture, or subsistence planting.
Animal husbandry: The feature is associated with the care of livestock.
Burial: Used for the interment of human skeletal remains. This functional category is also used for human remains found out of primary context.
Ceremonial: Used for ritual or religious purposes.
Fireplace: Burn pit or lens of burned material in a limited area.
Habitation: A place for living, which may be either temporary or permanent habitation. Habitation sites are generally distinguished from shelters by an increased energy investment in modification and formal construction.
Marker: A point visibly marked for the purpose of identifying a point on a line on the surface of the earth such as a boundary or trail.
Rock art: Petroglyphs and pictographs are functionally rock art.
Transportation: The feature was used as a road or trail.

Significance Assessments

Sites were evaluated for significance according to the broad criteria established for the State Register. 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 (shrines, heiau) and/or burials present.

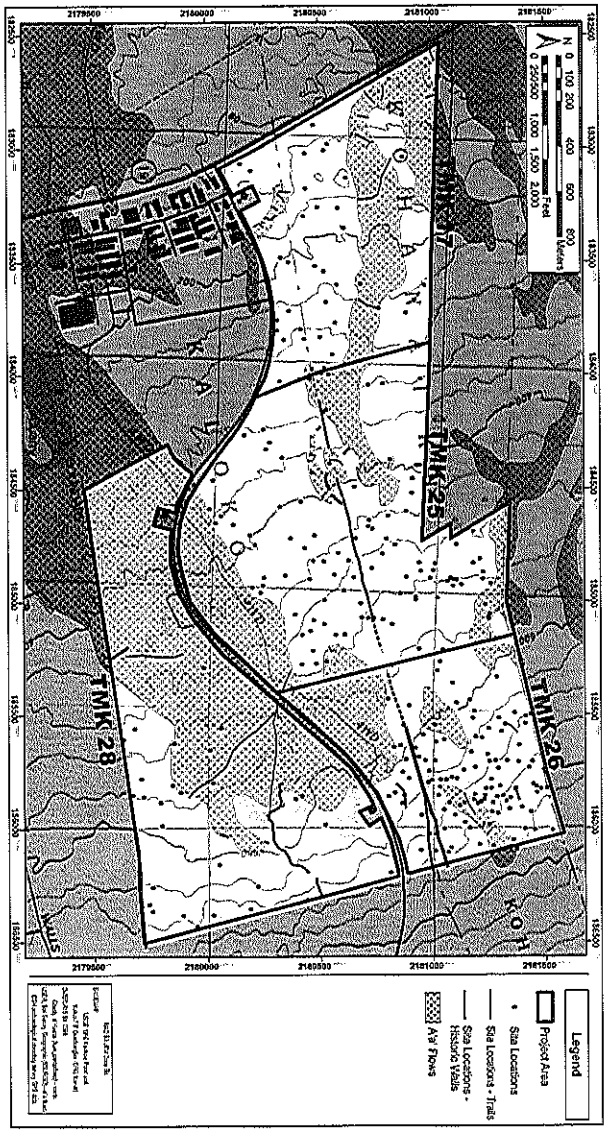

Figure 6. Historic properties location map for Kaloko Makai project area

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendation
20715	Terrace	Temporary habitation	D	Pre-Contact	Data Recovery
20716	Modified tumulus	Possible Burial	D,E*	Pre-Contact	Preservation
20717	Modified tumulus	Temporary habitation	D	Pre-Contact	No Further Work
20718	Modified tumulus	Agriculture	D	Pre-Contact	No Further Work
20719	Rock shelter / Hearth	Temporary habitation	D	Pre-Contact	Data Recovery
20720	Terrace	Possible Burial (destroyed)	D,E*	Pre-Contact	No Further Work
20721	Modified tumulus	Temporary habitation	D	Pre-Contact	Data Recovery
20722	Trail	Transportation	D	Pre-Contact	No Further Work
20724	Trail	Transportation	D	Pre-Contact	No Further Work
20725	Modified tumulus	Temporary habitation	D	Pre-Contact	Data Recovery
20726	Trail	Transportation	D	Pre-Contact	No Further Work
20727	Lava tube	Temporary habitation	D	Pre-Contact	Data Recovery
20728	Enclosure	Temporary habitation	D	Pre-Contact	No Further Work
20729	See -15329	N/A	N/A	N/A	No Further Work
20730	Modified tumulus	Temporary habitation	D	Pre-Contact	Data Recovery
20731	Modified tumulus	Indeterminate	D	Pre-Contact	No Further Work
20732	Trail	Transportation	D	Pre-Contact	No Further Work
20733	Trail	Transportation	D	Pre-Contact	No Further Work
20734	Modified depression	Agriculture	D	Pre-Contact	No Further Work
20735	See -15325	N/A	N/A	N/A	No Further Work
20736	Trail	Transportation	D	Pre-Contact	No Further Work
20737	Trail	Transportation	D	Pre-Contact	No Further Work
20738	Enclosure	Agriculture	D	Pre-Contact	No Further Work
20739	Enclosure / Trail	Transportation	D	Pre-Contact	No Further Work
20740	Modified tumulus	Agriculture	D	Pre-Contact	No Further Work
20742	Lava tube	Temporary habitation	D	Pre-Contact	No Further Work
20743	Modified tumulus	Indeterminate	D	Pre-Contact	No Further Work
20744	Trail	Transportation	D	Pre-Contact	No Further Work
20745	Trail	Transportation	D	Pre-Contact	No Further Work
20746	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work

Table 3. Archaeological Site Summary for TMK Parcel 17

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendation
13493	Trail	Transportation	D	Pre-Contact	No Further Work
15324	Trail	Transportation	D, E*	Pre-Contact	No Further Work
15325	Wall, modified depressions, mound	Temporary habitation / Transportation / Storage	D	Pre-Contact	Data Recovery
15329	Modified tumulus	Temporary habitation	D	Pre-Contact	No Further Work
20696	Lava tube	Temporary habitation	D	Pre-Contact	No Further Work
20697	Modified tumulus	Temporary habitation	D	Pre-Contact	Data Recovery
20698	Pavements	Temporary habitation	D	Pre-Contact	Data Recovery
20699	Modified tumulus	Indeterminate	D	Pre-Contact	No Further Work
20700	Modified tumulus, Enclosure	Temporary habitation / Agriculture	D	Pre-Contact	Data Recovery
20701	Modified tumulus	Temporary habitation	D	Pre-Contact	No Further Work
20702	Mod. tumulus/terrace	Temporary habitation	D	Pre-Contact	Data Recovery
20703	Terrace, Pavement, Modified tumulus	Temporary habitation / Mining	D	Pre-Contact	Data Recovery
20704	Trails, walls	Temporary habitation / Transportation	D	Pre-Contact	No Further Work
20705	Modified tumulus	Possible burial	D, E*	Pre-Contact	Preservation
20706†	Modified tumulus	Temporary habitation	D	Pre-Contact	No Further Work
20707	Lava tube	Temporary habitation	D	Pre-Contact	No Further Work
20708	Modified tumulus	Temporary habitation	D	Pre-Contact	Data Recovery
20709	Platform, enclosures, modified lava blister	Recurrent habitation / Agriculture / Storage	C,D	Pre-Contact	Preservation
20710	Lava tube, Alignment, Mound, Modified tumulus, Pavement	Temporary habitation	D	Pre-Contact	Data Recovery
20711	Enclosure	Temporary habitation	D	Pre-Contact	Data Recovery
20712	C-shape	Temporary habitation	D	Pre-Contact	No Further Work
20713	Cairn	Marker	D	Pre-Contact	No Further Work
20714	Wall	Temporary habitation	D	Pre-Contact	No Further Work

Table 4. Archaeological Site Summary for TMK Parcel 25

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendations
10712	Wall	Animal Husbandry	D	Historic	Preservation
20741	Complex	Temporary Habitation	C, D	Pre-Contact	Preservation
26275	Complex	Ceremonial	C, D, E	Pre-Contact	Preservation
26276	Modified depression	Temporary Habitation	D	Pre-Contact	No Further Work
26277	Complex	Temporary Habitation	D	Pre-Contact	Data recovery
26278	Trail	Transportation	D	Pre-Contact	No Further Work
26279	Modified outcrop	Indeterminate	D	Pre-Contact	No Further Work
26280	Lava blister	Temporary Habitation	D	Pre-Contact	No Further Work
26281	Mounds	Agriculture	D	Pre-Contact	No Further Work
26282	Lava blister	Temporary Habitation	D	Pre-Contact	No Further Work
26283	Enclosure	Temporary Habitation	D	Pre-Contact	No Further Work
26284	Complex	Permanent Habitation	C, D	Pre-Contact	Preservation
26285	Enclosure	Temporary Habitation	D	Pre-Contact	No Further Work
26286	Modified outcrop	Quarry	D	Pre-Contact	No Further Work
26287	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26288	Complex	Temporary Habitation	C, D	Pre-Contact	Preservation
26289	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26290	Lava tube	Burial	D, E*	Pre-Contact	Preservation
26291	Lava tube	Temporary Habitation/Quarry	D	Pre-Contact	Data Recovery
26292	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26293	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26294	Wall	Indeterminate	D	Pre-Contact/ Historic	No Further Work
26295	Cairn	Marker	D	Pre-Contact	No Further Work
26296	Enclosure	Permanent Habitation	C, D	Pre-Contact/ Historic	Preservation
26297	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26298	Platform	Temporary Habitation	D	Pre-Contact	No Further Work
26299	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26300	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26301	Terrace	Temporary Habitation	D	Pre-Contact	No Further Work

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendation
20747	Trail	Transportation	D	Pre-Contact	No Further Work
20748	Lava tube	Storage	D	Pre-Contact	No Further Work
20749	Lava tube, terrace	Temporary habitation	D	Pre-Contact	Data Recovery
26259	Trail	Transportation	D	Pre-Contact	No Further Work
26260	Lava tube	Temporary habitation	D	Pre-Contact	Data Recovery
26261	Terrace	Temporary habitation	D	Pre-Contact	Data Recovery
26262	C-shape	Temporary habitation	D	Pre-Contact	No Further Work
26263	Lava tube	Temporary habitation	D	Pre-Contact	Data Recovery
26264	Modified tumulus	Agriculture	D	Pre-Contact	No Further Work

* Site is a probable burial

† Site was found to be outside project area

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendations
26332	Enclosure	Temporary Habitation	D	Pre-Contact	No Further Work
26333	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26334	Complex	Temporary Habitation	D	Pre-Contact	Data recovery
26335	Enclosure	Permanent Habitation	D	Pre-Contact	No Further Work
26336	Trail	Transportation	D	Pre-Contact	No Further Work
26337	Complex	Temporary Habitation	D	Pre-Contact	Data recovery
26338	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26339	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26340	Trail	Transportation	D	Pre-Contact	No Further Work
26341	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26342	Lava tube	Temporary Habitation	D	Pre-Contact/ Historic	Data recovery
26343	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26344	Complex	Permanent Habitation	D	Pre-Contact	Data recovery
26345	Modified outcrop/ Lava tube	Quarry	D	Pre-Contact	No Further Work
26346	Trail	Transportation	D	Pre-Contact	No Further Work
26347	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26348	Complex	Permanent Habitation	C, D	Pre-Contact	Preserve
26349	Complex	Temporary Habitation	D	Pre-Contact	Data recovery
26350	Complex	Permanent Habitation	C, D	Pre-Contact	Preserve
26351	Lava blister	Temporary Habitation	D	Pre-Contact	No Further Work
26352	Cairn	Marker	D	Historic	No Further Work
26353	Trail	Transportation	D, E	Pre-Contact	Preserve
26354	Complex	Temporary Habitation	D	Pre-Contact	Data recovery
26355	Trail/Wall	Transportation	D	Pre-Contact/ Historic	No Further Work
26356	Lava blister	Temporary Habitation	D	Pre-Contact	No Further Work
26357	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26358	Unknown/Bulldozed	Habitation/Indeterminate	D	Pre-Contact	No Further Work
26359	Trail	Transportation	D	Pre-Contact	No Further Work
26360	Wall	Animal Husbandry	D	Historic	No Further Work

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendations
26302	Cairn	Marker	D	Pre-Contact	No Further Work
26303	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26304	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26305	Modified outcrop	Temporary Habitation	D	Pre-Contact	No Further Work
26306	Modified outcrop	Indeterminate	D	Pre-Contact	No Further Work
26307	Complex	Ceremonial	C, D, E	Pre-Contact	Preservation
26308	Enclosure	Temporary Habitation	D	Historic	No Further Work
26309	Complex	Temporary Habitation	D	Pre-Contact	No Further Work
26310	Lava tube	Temporary Habitation/Burial	D, E*	Pre-Contact	Preservation
26311	Lava tube	Burial	D, E*	Pre-Contact	Preservation
26312	Cairn	Marker	D	Pre-Contact	No Further Work
26313	Enclosure	Temporary Habitation	D	Pre-Contact	No Further Work
26314	Enclosure	Permanent Habitation	D	Pre-Contact	No Further Work
26315	Complex	Temporary Habitation	D	Pre-Contact	Data recovery
26316	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26317	Lava tube	Temporary Habitation/Quarry	D	Pre-Contact	No Further Work
26318	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26319	Lava tube	Activity Area	D	Pre-Contact	No Further Work
26320	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26321	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26322	Cairn	Marker	D	Pre-Contact	No Further Work
26323	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26324	Lava tube	Temporary Habitation	D, E**	Pre-Contact	Preserve
26325	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26326	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26327	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26328	Platform	Temporary Habitation	D	Pre-Contact	Data recovery
26329	Enclosure	Temporary Habitation	D	Pre-Contact	No Further Work
26330	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26331	Complex	Permanent Habitation	C, D	Pre-Contact	Preserve

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendations
26390	Lava Blister	Temporary Habitation	D	Pre-Contact	No Further Work
26391	Lava Tube	Temporary Habitation	D	Pre-Contact	No Further Work
26392	Mound	Agriculture	D	Pre-Contact	No Further Work
26393	Mound	Agriculture	D	Pre-Contact	No Further Work

* Site contains confirmed human remains

** Site contained human remains removed during a previous study (Kennedy 1983/1984)

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendations
26361	Trail	Transportation	D	Pre-Contact	No Further Work
26362	Lava tube	Burial	D, E*	Pre-Contact	Preserve
26363	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26364	Lava tube	Temporary Habitation	D, E	Pre-Contact	Preserve
26365	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26366	Wall	Animal Husbandry	D	Historic	No Further Work
26367	Enclosure	Animal Husbandry	D	Historic	No Further Work
26368	Trail	Transportation	D	Pre-Contact	No Further Work
26369	Trail	Transportation	D	Pre-Contact	No Further Work
26370	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26371	Trail	Transportation	D	Historic	No Further Work
26372	Trail	Transportation	D	Pre-Contact	No Further Work
26373	Lava tube	Temporary Habitation	D	Pre-Contact/ Historic	Data recovery
26374	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26375	Modified outcrop	Quarry	D	Pre-Contact	No Further Work
26376	Enclosure	Temporary Habitation	D	Pre-Contact	No Further Work
26377	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26378	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26379	Complex	Temporary Habitation/ Agriculture	D	Pre-Contact	Data recovery
26380	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26381	Enclosure	Permanent Habitation	C, D	Pre-Contact	Preserve
26382	Trail	Transportation	D	Pre-Contact	No Further Work
26383	Enclosure	Temporary Habitation	D	Pre-Contact	No Further Work
26384	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26385	Mounds	Temporary Habitation	D	Pre-Contact	No Further Work
26386	Modified outcrop	Activity Area	D	Pre-Contact	No Further Work
26387	Modified outcrop	Activity Area	D	Pre-Contact	No Further Work
26388	Lava tube	Temporary Habitation	D	Pre-Contact	Data recovery
26389	Enclosure	Permanent Habitation	D	Pre-Contact	Data recovery

SIHP No. 50-10-28-	Site Type	Function	Significance	Age	Mitigation Recommendations
26490	Lava tube	Shelter	D	Pre-Contact	No Further Work
26491	Platform	Permanent Habitation	D	Pre-Contact	No Further Work
26492	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26493	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26494	Complex	Permanent Habitation	D	Pre-Contact	Preservation
26495	Lava tube	Temporary Habitation	D	Pre-Contact	Preservation & Data Recovery
26496	Complex	Temporary Habitation	D	Pre-Contact	No Further Work
26497	Modified outcrop	Indeterminate	D	Pre-Contact	No Further Work
26498	Lava tube	Temporary Habitation & Burial	D, E	Pre-Contact	Preservation & Data Recovery
26499	Lava tube	Shelter	D	Pre-Contact	Data Recovery
26500	Lava tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26501	Lava tube	Water Collection & Burial	D, E*	Pre-Contact	Preservation
26502	Complex	Permanent Habitation	D	Pre-Contact	Data Recovery
26503	Lava tube	Water Collection & Burial	D, E	Pre-Contact	Preservation
26504	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26505	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26506	Lava tube	Shelter	D	Pre-Contact	No Further Work
26507	Complex	Agriculture	D	Pre-Contact	Data Recovery
26508	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26509	Lava tube	Burial	D, E	Pre-Contact	Preservation
26510	Complex	Water Collection, Burial, & Ceremonial	D, E	Pre-Contact	Preservation & Data Recovery
26511	Lava tube	Shelter	D	Pre-Contact	No Further Work
26512	Lava tube	Shelter	D	Pre-Contact	No Further Work
26513	Complex	Temporary Habitation	D	Pre-Contact	Data Recovery
26514	Complex	Permanent Habitation	D	Pre-Contact	Data Recovery
26515	Platform & Cairns	Burial & Marker	D, E	Pre-Contact	Preservation
26516	Modified outcrop	Storage	D	Pre-Contact	No Further Work

Table 5. Archaeological Site Summary for TMK Parcel 26 (Keahole Pt. Quad)

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendations
10712	Wall	Animal Husbandry	D	Historic	Preservation
26418	Trail	Transportation	D	Pre-Contact	No Further Work
26475	Lava tube	Shelter	D	Pre-Contact	No Further Work
26476	Mound	Agriculture	D	Historic	No Further Work
26477	Lava tube	Shelter	D	Pre-Contact	No Further Work
26478	Complex	Temporary Habitation & Burial	D, E	Pre-Contact	Preservation & Data Recovery
26479	Enclosure	Permanent Habitation	D	Pre-Contact	No Further Work
26480	Lava tube	Shelter & Burial	D, E	Pre-Contact	Preservation
26481	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26482	Lava tube	Water Collection	D	Pre-Contact	Data Recovery
26483	Lava tube	Water Collection	D	Pre-Contact	Data Recovery
26484	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26485	Lava tube	Permanent Habitation	D	Pre-Contact	Data Recovery

Table 6. Archaeological Site Summary for TMK Parcel 26 (Kailua Quad)

SIHP No. 50-10-28-	Site Type	Function	Significance	Age	Mitigation Recommendations
5699	Wall	Animal Husbandry	D	Historic	No Further Work
6601	Complex	Agriculture	D	Pre-Contact	Data Recovery
10714	Trail	Transportation	D, E	Pre-Contact/ Historic	Preservation
16103	Lava tube	Permanent Habitation & Burial	D, E	Pre-Contact	Preservation & Data Recovery
26486	Complex	Permanent Habitation	D	Pre-Contact	Preservation
26487	Enclosure	Permanent Habitation	D	Pre-Contact	No Further Work
26488	Lava tube	Burial	D, E	Pre-Contact	Preservation
26489	Complex	Permanent Habitation	D, E	Pre-Contact	Preservation

SIHP No. 50-10-28-	Site Type	Function	Significance	Age	Mitigation Recommendations
26543	Wall	Marker	D	Pre-Contact	No Further Work
26544	Enclosure	Permanent Habitation	C, D	Pre-Contact	Preservation
26545	Lava tube	Activity Area	D	Pre-Contact	Data Recovery
26546	Lava tube	Water Collection	D	Pre-Contact	Data Recovery
26547	Lava tube	Burial	D, E	Pre-Contact	Preservation
26548	Lava tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26549	Terrace	Agriculture	D	Pre-Contact	No Further Work
26550	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26551	Modified outcrop	Quarrying	D	Pre-Contact	No Further Work
26552	Complex	Permanent Habitation	D	Pre-Contact	Data Recovery
26553	Lava tube	Temporary Habitation	D	Pre-Contact	No Further Work
26554	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26555	Lava tube	Shelter	D	Pre-Contact	No Further Work
26556	Platform	Burial	D, E	Pre-Contact	Preservation
26557	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26558	Platform	Permanent Habitation	D	Pre-Contact	Data Recovery
26559	Platform	Burial	D, E	Pre-Contact	Preservation
26560	Trail	Transportation	D, E	Pre-Contact	No Further Work
26561	Cairn	Marker	D	Pre-Contact	No Further Work
26562	Complex	Permanent Habitation & Burial	D, E	Pre-Contact	Preservation
26563	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26564	Lava tube	Burial	D, E	Pre-Contact	Preservation
26565	Complex	Permanent Habitation	D	Pre-Contact	Data Recovery
26566	Lava tube	Water Collection	D	Pre-Contact	Data Recovery
26567	Mound	Agriculture	D	Pre-Contact	No Further Work
26568	Lava tube	Water Collection & Burial	D, E	Pre-Contact	Preservation
26569	Lava tube	Water Collection & Burial	D, E	Pre-Contact	Preservation
26570	Lava tube	Water Collection & Burial	D, E	Pre-Contact/ Historic	Preservation
26571	Cairn	Marker	D	Pre-Contact	No Further Work

SIHP No. 50-10-28-	Site Type	Function	Significance	Age	Mitigation Recommendations
26517	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26518	Enclosure	Permanent Habitation	D	Pre-Contact	No Further Work
26519	Complex	Permanent Habitation	C, D, E	Pre-Contact	Preservation
26520	Lava tube	Burial, Ceremonial, & Animal Husbandry	D, E	Pre-Contact/ Historic	Preservation & Data Recovery
26521	Lava tube	Shelter	D	Pre-Contact	Data Recovery
26522	Lava tube	Burial & Water Collection	D, E	Pre-Contact/ Historic	Preservation & Data Recovery
26523	Platform	Temporary Habitation	D	Pre-Contact	No Further Work
26524	Lava tube	Shelter	D	Pre-Contact	No Further Work
26525	Lava tube	Shelter	D	Pre-Contact	No Further Work
26526	Cairn	Marker	D	Pre-Contact	No Further Work
26527	Lava tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26528	Lava tube	Water Collection	D	Pre-Contact	Data Recovery
26529	Lava tube	Water Collection & Burial	D, E	Pre-Contact	Preservation
26530	Platform	Temporary Habitation	D	Pre-Contact	No Further Work
26531	Enclosure	Agriculture	D	Pre-Contact	No Further Work
26532	Lava tube	Temporary Habitation & Burial	D, E	Pre-Contact	Preservation
26533	Platform	Agriculture	D	Pre-Contact	No Further Work
26534	Complex	Permanent Habitation	C, D	Historic	Preservation
26535	Platform	Permanent Habitation	D	Pre-Contact	No Further Work
26536	Wall	Animal Husbandry	D	Historic	No Further Work
26537	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26538	Lava tube	Temporary Habitation & Burial	D, E	Pre-Contact	Preservation & Data Recovery
26539	Complex	Temporary Habitation	D	Pre-Contact	No Further Work
26540	Cairn	Marker	D	Pre-Contact	No Further Work
26541	Cairn	Marker	D	Pre-Contact	No Further Work
26542	Platform	Temporary Habitation	D	Pre-Contact	No Further Work

Table 7. Archaeological Site Summary for TMK Parcel 28 (Keahole Pt. Quad)

SIHP No. 50-10-27-	Site Type	Function	Significance	Age	Mitigation Recommendations
26371	Trail	Transportation	D	Historic	Preserve
26414	Wall	Animal Husbandry	D	Historic	Preserve
26415	Trail	Transportation	D	Pre-Contact	No Further Work
26416	Lava Tube	Burial	D, E	Pre-Contact	Preserve

Table 8. Archaeological Site Summary for TMK Parcel 28 (Kailua Quad)

SIHP No. 50-10-28-	Site Type	Function	Significance	Age	Mitigation Recommendations
26417	Mounds/Modified Depressions	Agriculture	D	Pre-Contact	No Further Work
26418	Trail	Transportation	C, D	Pre-Contact	Preserve
26419	Trail	Transportation	D	Pre-Contact	No Further Work
26420	Lava Tube	Activity Area	D	Pre-Contact	No Further Work
26421	Lava Tube	Temporary Habitation	D	Pre-Contact	No Further Work
26422	Trail	Transportation	D	Pre-Contact	No Further Work
26423	Lava Tube/ Modified Tumulus	Burial	D, E	Pre-Contact	Preserve
26424	Enclosure	Ceremonial	C, D, E	Pre-Contact	Preserve
26425	Lava Tube/ Modified Tumulus	Temporary Habitation/ Burial	D, E	Pre-Contact	Preserve & Data Recovery
26426	Modified Tumulus	Marker	D	Historic	No Further Work
26427	Lava Tube	Burial	D, E	Pre-Contact	Preserve
26428	Platform	Permanent Habitation	D	Pre-Contact	Data Recovery
26429	Modified Tumulus	Activity Area	D	Pre-Contact	No Further Work
26430	Modified Tumulus/ Platform/Terrace	Temporary Habitation	D	Pre-Contact	Data Recovery
26431	Lava Tube	Activity Area	D	Pre-Contact	Data Recovery

SIHP No. 50-10-28-	Site Type	Function	Significance	Age	Mitigation Recommendations
26572	Complex	Agriculture	D, E	Pre-Contact	No Further Work
26573	Lava tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26574	Complex	Permanent Habitation	D, E	Pre-Contact	Preservation
26575	Lava tube	Water Collection	D	Pre-Contact	No Further Work
26576	Lava tube	Burial & Shelter	D, E	Pre-Contact	Preservation
26577	Mound	Permanent Habitation	D	Pre-Contact	Data Recovery
26578	Lava tube	Shelter	D	Pre-Contact	Data Recovery
26579	Cairn	Marker	D	Pre-Contact	No Further Work
26580	Enclosure	Permanent Habitation	D	Pre-Contact	Preservation
26581	Lava tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26582	Lava tube	Burial	D, E	Pre-Contact	Preservation
26583	Complex	Permanent Habitation & Ceremonial	C, D, E	Pre-Contact	Preservation
26584	Complex	Transportation	D	Pre-Contact	No Further Work
26585	Complex	Agriculture & Temporary Habitation	D	Pre-Contact	No Further Work
26586	Cairn	Marker	D	Pre-Contact	No Further Work
26587	Platform	Agriculture	D	Pre-Contact	No Further Work
26588	Enclosure	Permanent Habitation	C, D	Pre-Contact	Preservation

* Site is a probable burial

SIHP No. 50-10-28-	Site Type	Function	Significance	Age	Mitigation Recommendations
26432	Wall	Animal Husbandry	D	Historic	No Further Work
26433	Trail	Transportation	D	Pre-Contact	No Further Work
26434	Lava Tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26435	Wall	Animal Husbandry	D	Historic	No Further Work
26436	Wall/Cairn	Animal Husbandry	D	Historic	No Further Work
26437	Cairn	Marker/Animal Husbandry	D	Historic	No Further Work
26438	Lava Tube	Temporary Habitation/ Burial	D, E	Pre-Contact	Preserve & Data Recovery
26439	Lava Tube	Temp. Habitation	D	Pre-Contact	Data Recovery
26440	Lava Tube	Temporary Habitation/ Burial*	D, E	Pre-Contact	Preserve
26441	Lava Tube	Activity Area	D	Pre-Contact	No Further Work
26442	Wall	Animal Husbandry	D	Historic	No Further Work
26443	Enclosure	Permanent Habitation	D	Pre-Contact	Preserve
26444	Wall	Animal Husbandry	D	Historic	No Further Work
26445	Modified Tumulus	Temporary Habitation	D	Pre-Contact	Data Recovery
26446	Lava Tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26447	Lava Tube	Temporary Habitation	D	Pre-Contact	No Further Work
26448	Modified Tumulus	Temporary Habitation	D	Pre-Contact	No Further Work
26449	Lava Tube	Temporary Habitation	D	Pre-Contact	Data Recovery
26450	Wall	Animal Husbandry	D	Historic	No Further Work
26451	Modified Tumulus	Temporary Habitation	D	Pre-Contact	No Further Work
26452	Lava Tube	Activity Area**	D, E	Pre-Contact	Preserve & Data Recovery
26453	Platform	Burial*	D, E	Pre-Contact	Preserve

* Site is a probable burial

** Site contains burials located outside of the project area

Summary of Feature Types and Site Function

Table 9 tallies the total occurrences of these formal feature types in the Kaloko Makai project area by parcel. There are a total of 658 features in the project area at 341 sites. Lava tubes are the most common feature type, and are particularly dense in TMK 26. Other common feature types include modified outcrops, enclosures, platforms, walls and trails. The majority of these feature types in the project area predominantly represent a pre-contact style of land use. Walls are an exception to this pattern as many are related to post-contact animal husbandry, including the landmark *ahupua'a* wall running through much of the project area. Other post-contact sites are relatively few, but include burials, trails and at least one enclosure as a post-contact habitation.

Percentages of functional categories are summarized in Table 10. These percentages represent the primary functional types for each site. Since some sites have multiple primary functions (i.e. a site may have both a habitation component as well as being a burial location), only overall percentages are given rather than total counts, as more than one functional category may be counted for a single site. Habitation is by far the most common function for sites within the project area, with permanent habitation increasing in the *mauka* parcel (TMK 26). Burial is also a common function, especially in TMK 26. Temporary habitation and trails are more common in the *makai* parcels.

Table 9. Summary Occurrences of Formal Feature Types (Total number of features: 658)

Feature Type	TMK 17		TMK 25		TMK 26		TMK 28		All TMKs	
	No.	%	No.	%	No.	%	No.	%	No.	%
Alignment	1	1	3	1.4	2	0.7	0	0	6	0.9
Cairn	1	1	8	3.6	17	6.1	2	3.3	28	4.3
Cupboard	2	2	0	0	0	0.0	0	0	2	0.3
Enclosure	12	12.1	31	14	19	6.9	2	3.3	64	9.7
Hearth	1	1	0	0	1	0.4	0	0	2	0.3
Lava blister	1	1	5	2.3	2	0.7	0	0	8	1.2
Lava tube	10	10.1	80	36.2	70	25.3	17	27.9	177	26.9
Modified depression	2	2	9	4.1	4	1.4	4	6.6	19	2.9
Modified outcrop	26	26.3	14	6.3	16	5.8	9	14.7	65	9.9
Mound*	3	3	8	3.6	26	9.4	4	6.6	41	6.2
Pavement	7	7.1	6	2.7	5	1.8	0	0	18	2.7
Platform	2	2	8	3.6	44	15.9	5	8.2	59	9.0
Rock art	0	0	2	0.9	4	1.4	0	0	6	0.9
Rock shelter	1	1	0	0	0	0.0	0	0	1	0.2
Terrace	7	7.1	13	5.9	23	8.3	3	4.9	46	7.0
Trail	21	21.2	17	7.7	12	4.3	7	11.5	57	8.7
Wall	2	2	17	7.7	32	11.6	8	13.1	59	9.0
Total # of Features (% of total features)	**99 (15%)**		**221 (34%)**		**277 (42%)**		**61 (9%)**		**658 (100%)**	

*There are several pervasive agricultural sites in the project area with widespread clearing and planting mounds. As these individual mounds are considered sub-features of the larger sites, each site/feature counts as one occurrence of the formal feature type.

Table 10. Summary Occurrences of Formal Site Function (Total number of sites: 341*)

Function	TMK 17		TMK 25		TMK 26		TMK 28		TOTAL
	No.	%	No.	%	No.	%	No.	%	%
Activity Area	0	0.0	3	2.3	24	17.1	3	7.0	**8.0**
Agriculture	7	10.6	4	3.1	9	6.4	1	2.3	**5.6**
Animal husbandry	0	0.0	4	3.1	3	2.1	7	16.3	**3.7**
Burial (Known)	0	0.0	5	3.9	24	17.9	5	11.6	**9.3**
Burial (Probable)	3	4.5	1	0.8	2	2.1	2	4.7	**2.4**
Ceremonial	0	0.0	2	1.6	2	1.4	1	2.3	**1.3**
Indeterminate	3	4.5	4	3.1	1	0.7	0	0.0	**2.1**
Marker	1	1.5	5	3.9	8	5.7	2	4.7	**4.2**
Quarrying	1	1.5	5	3.9	1	0.7	1	2.3	**2.1**
Storage	3	4.5	0	0.0	1	0.7	0	0.0	**1.1**
Permanent Habitation	1	1.5	10	7.8	25	17.9	2	4.7	**10.1**
Temporary Habitation	31	47.0	72	56.3	34	24.3	13	30.2	**39.8**
Transportation	16	24.2	13	10.2	4	2.9	6	14.0	**10.3**

*Since some sites have dual primary functions, i.e. habitation and burial, these functions are each counted as one instance each in the table; thus, the total counts for each parcel here are slightly different than the actual total number of sites (341), for this table only.

SUMMARY AND INTERPRETATION

Summary of Site Type and Function within the Project Area

The inventory survey of the more than 1100-acre parcel resulted in the identification and documentation of 341 archaeological sites. Based on historic background literature and previous archaeological studies, the site density appears consistent with general ideas about settlement of this area (see the Background Research section of this report), with site density increasing substantially in the *mauka* portions of the project area. The types, functions, and distribution of sites present match closely the anticipated finds for the Intermediate and Upland zones of the Kekaha region of North Kona within which the project area lies.

The Kekaha region, or "Kekaha-Waiole, the desolate land without water" (Kelly 1973:74) refers to the barren lava fields extending north from Kailua-Kona to Anaeho'omalu (Kelly 1973:74). As has been observed in Kaloko, Kohanaiki and other *ahupua'a* in Kekaha, this band of barren lava fields does not encompass the entire *ahupua'a* nor does it inhibit land usage from occurring along the coast and inland where rainfall is sufficient for intensive agriculture. Instead, Kekaha refers more accurately to portions or "zones" of the regions where lava flows encompass the lands which - according to elevation - sustain little rainfall. Correspondingly, the lands of Kekaha are suggested, based on ethnographies, ethno-histories and archaeological sources, to contain three general terrestrial zones that directly influenced land usage of prehistoric and historic populations. These three zones include: (1) Coastal; (2) Intermediate or Transitional and; (3) Upland.

The current project area falls into the Intermediate and Upland Zones. Based on the archaeological record of the present study area and previous archaeology in the Kaloko *ahupua'a* (Cordy et al. 1991), the Intermediate Zone contained a scattered distribution of habitations of different modes (i.e. temporary and recurrent) which were generally located within the vicinity of *mauka/makai* trails or in association with other functional site types like agricultural and lithic resource procurement. The general lack of consistent rainfall and virtual absence of soil directly limits agricultural use within the Intermediate Zone. Nonetheless, small concentrations of mounds, modified outcrops (enclosing minimal soil areas), enclosures, and some *pāhoehoe* excavations evidence a degree of agricultural productivity. Lava tubes and blisters are abundant in this zone and contain temporary components, and post-habitation burial interments. The Intermediate Zone is also characterized by an extensive network of *mauka/makai* trails. These trails facilitated inter-*ahupua'a* travel of residence between their coastal habitation and the Upland agricultural fields. TMK 17, TMK 25, and the *makai* portion of TMK 28 are located in the Intermediate Zone.

In contrast, the Upland Zone is characterized by an increase in permanent habitation sites, in association with intensive non-irrigated (dry land) agricultural features. Gradually, the ascending natural landscape contains a greater soil base and due to an increase in elevation, the rainfall is more plentiful and consistent. The *mauka* portion of the project area in TMK 26 and TMK 28 is located within this zone. Intensive non-irrigated agriculture is characteristic of the Kona slopes and other regions of Hawaii and Maui where irrigation, because of the lack of perennial waterways, is not possible.

The present project area's location within the interpreted Intermediate and Upland Zones places it within an area where an increase of permanent habitation and agricultural intensity is expected

upslope. The lower elevation (*makai*) portion of the project area is closer to the "intermediate zone" and therefore is somewhat outside the major areas of pre-contact Hawaiian habitation and activity; a lower density of archaeological sites is expected in this region. The higher (*mauka*) regions of the project area have higher rainfall, some soil formation, and a greater number of large lava tubes; overall, density of sites increases with elevation as expected.

Historic properties within the project area range from the pre-contact period to the historic ranching era. Feature types typically involve formal and informal stone construction (ranging from formal habitation and ceremonial structures to informal shelters and planting/clearing mounds), modification of lava tubes, construction of trails, and agricultural modification and clearing. Site functions include habitation, burial, ceremonial, transportation, agriculture, water collection and animal husbandry among other minor functions such as storage and quarrying. The following discussion summarizes the most common types of modification present within the Kaloko Makai project area and discusses the interpreted function of these sites, with a summary of site distributions and overall conclusions following.

Agriculture

The terrain throughout the majority of the project area severely limits agricultural productivity, since large portions of the project area are barren *'a'ā* lava or rough *pāhoehoe* with no soil development. However, some of the *pāhoehoe* areas do have soil development, although these tend to be fairly small and shallow everywhere except for the far *mauka* extent of the project area. The agriculture related features throughout most of the lower elevations of the project area represent more of an opportunistic approach versus the more expansive/intensive approach practiced at higher, more productive elevations.

Agricultural features in the project area ranged from minimal constructions, characterized by the removal of stones to clear small depressions in *pāhoehoe* lava, to larger more defined concentrations of clearing and/or planting mounds. Other agricultural features included excavated blisters, informal enclosures, terracing, and the use of small cobble mulch. Throughout most of the project area, these features are fairly informal and somewhat ephemeral, tending to occur in low density concentrations often in gulch areas or low natural depressions in the topography. In the *mauka* portion of the southern parcel (TMK 28), eroded *'a'ā* flows appear to be used as planting areas with high concentrations of small *'a'ā* cobble mounds in geologically distinct areas.

The agricultural sites within the project area are collectively characteristic of and are a variation of what is currently termed the "Kona Field System" (State site 50-10-37-6601). The Kona Field System is an intensive, non-irrigated dry land agriculture complex, which has been identified along the upland slopes of North and South Kona, leeward Hawai'i, from Kealakekua Bay to beyond the northern limits of Kailua Town. Numerous archaeological studies in this region (e.g., Newman 1970; Yen 1978; Schilt 1984; Barrera 1990; Hammatt et al. 1995, among others) define the field system as a grid-like patterning of rectangular fields formed by earthen and stone boundaries. Although variants occur, the fields' long axis walls (*kuaīwi*) extend in a *mauka/makai* direction and are intersected by shorter walled boundaries cross-cutting the slope.

The definition of the Kona Field System as a "system" relies on the interaction of four terrestrial ecozones or subzones classifying areas of differential agricultural use in *ahupua'a* or district, as it is most commonly applied. Classification of these subzones was initially introduced by T. Stell

Newman (1970) with subsequent contributions by Marion Kelly (1983). Newman defined the terrestrial subzones using aerial photography in correlation with historic accounts of early visitors to Hawai'i. Kelly's subsequent research of the Native Claims Registers (from 1846 to 1848) provided Hawaiian names of the subzones and, based on reported claims, what type of traditional or historic crop was cultivated in each subzone. The subzones follow rainfall gradients generally predicted by elevation in Kona and delineate optimum areas for intensive agriculture. Rose Schilt in "Subsistence and Conflict in Kona Hawai'i" presents a comprehensive summary of the subzones using Newman and Kelly's studies and rainfall data compiled during her research (Schilt 1984:6). The following subzone classifications are based on Schilt's compiled data (the first and second zones, *Kula* and *Kaluulu*, are most applicable to the present study area):

Kula Subzone/Coastal Area

Elevation: Sea level to 500 ft (0 to 150 m)
Annual Rainfall: c. 30-50 in. (0.8-1.2 mm.)
Late Pre-contact crops: Sweet potatoes (*'uala*), gourd (*ipu*), and mulberry (*wauke*).

Kaluulu Subzone/Seaward Slope

Elevation: 500-1000 ft. (c. 150-300 m)
Annual Rainfall: c. 40-55 in. (1.00-1.35 mm.)
Late Pre-contact Crop: Breadfruit (*'ulu*), with sweet potatoes (*'uala*) and mulberry (*wauke*) interspersed; mountain apple (*'ōhia'ai*) and some taro (*kalo*).

'Apa'a Subzone/Upland Slope

Elevation: 1000-2500 ft (300-750 m)
Annual Rainfall: c. 55-80 in. (1.35-2.00 mm.)
Late Pre-contact Crop: Taro (*kalo*), sweet potatoes (*'uala*), ti (*kā*), and sugarcane (*kō*).

'Ama'u Subzone/Upland Jungle

Elevation: 2500-4000 ft (750-1200 m)
Annual Rainfall: c. 80 in. (2.0 mm.)
Pre-contact Crops: Bananas and plantains (*mai'a*)

It is notable that historic period crops were also cultivated in the *Kaluulu* and *'Apa'a* subzones and to a lesser degree in the *Kula* subzone. These crops included cabbage, melons, onions, oranges, tobacco, beans, coffee, corn, cotton, pineapple, Irish potatoes, and pumpkin.

The agricultural sites within the project area are regarded as interrelated components of a non-intensive, non-irrigated field system with the *ahupua'a*, and are believed to generally reflect utilization of the *Kula* and *Kaluulu* subzones presented above. Given relatively low rainfall within most of the project area, despite its slightly higher elevation, it is reasonable to assume that most areas follow a pattern more consistent with the *Kula* subzone. Overall, this suggests that sweet potato, gourds, mulberry, and possibly taro are the most likely crops to have been grown in this area. As noted in the Background Research section above, the actual crops identified in the award testimonies during the Māhele of 1848 for Kaloko lands are taro and sweet potato.

Sweet potato was likely the most abundantly grown crop in the *makai* portion of the project area because of its adaptability to stony and dry environments. It was commonly planted in mounds and in *pāhoehoe* excavations. Henry J. Lyman son of missionary couple that first arrived in Hilo in 1831, describes features in Puna similar to *pāhoehoe* clearings, as seen in the project, which were cultivated with sweet potatoes:

> Whereever the lava could be pounded into scoria, a plantation of sweet potatoes was laboriously formed by digging among the stones and filling in the holes with dried grass brought from the mountainside. Placed in the nest, the tuberous buds were covered with gravel, and there grew with astonishing luxuriance, yielding the largest and finest potatoes on the island [in Frierson 1991:167].

During the mid 1800's, Captain Charles Wilkes of the American Exploring Team comments on the agricultural use of *pāhoehoe* excavations (similar to the modification of *pāhoehoe* outcrop seen in the project) which he observed specifically in the Kona region:

> Cultivation is carried on in many places where it would be deemed almost impractical in any other country. The natives, during the rainy season, also plant, in excavations among the lava rocks, sweet potatoes, melons, and pine-apples, all of which produce a crop (Wilkes 1845:91).

Sweet potatoes were also cultivated within walled fields or depressions in the walls themselves. E.S. Craighill Handy and Elizabeth Green Handy reveal this method using an account taken from the Hawaiian newspaper *Ka Nupepa Ku'oko'a* March 24, 1922):

> Rocky lands in the olden days were walled up all around with the big and small stones of the patch until there was a wall (*kuaīwi*) about 2 feet high and in the enclosure were put weeds of every kind, *'ī* tree ferns and so on, and then topped well with soil taken from the patch itself, to enrich tī, or in other words to rot the rubbish and weeds to make soil.
>
> After several months, the rotted weeds were converted into soil of the best grade. The farmer waited for the time when he knew that the rains would fall, then he made the patch ready for planting. If for sweet potatoes, he made mounds for them and for taro too, on some places on Hawai'i [in Handy and Handy 1972:131].

The above accounts describe agricultural modifications in rough rocky terrain similar to that of the present project area; while no walled (i.e. *kuaīwi*) fields are present in the *makai* portions of the project area, there are several located in the *mauka* portion of TMK 26.

In contrast, the *mauka* portion of the project area has increased rainfall at the higher elevation and considerably more formal agricultural modification, consistent with the area formally designated as the Kona Field System (Site -6601). This upland area would likely have been able to support a wider range of crops, likely including breadfruit (*'ulu*), sweet potatoes (*'uala*), with interspersed mulberry (*wauke*), mountain apple (*'ōhia'ai*) and some taro (*kalo*). It is interesting to note that some of the upland enclosures within Site -6601 in the project area are likely for arboriculture, which were not observed in lower elevation agricultural areas.

Animal Husbandry

Walls built for animal husbandry were a commonly identified feature type throughout the project area. The walls suggest a fairly major historic presence of cattle or goat ranching within the southeastern portion of the project area, which is not unexpected given the presence of the Huehue Ranch in Kaloko beginning in the late nineteenth and early twentieth century. The presence of barbed wire fences, troughs, and sheds in association with historic walls (primarily in TMK 28) suggests that ranching continued into the modern area. Other definitive signs of animal husbandry in the area are the large number of goat (and cattle) skeletons found in lava tubes.

Historical research suggests that both goat and cattle grazing probably took place within the project area. Captain George Vancouver gave Ke'eaumoku, an *ali'i*, a pair of goats in 1792, and the following year, he brought Ke'eaumoku four sheep. Vancouver also brought the first cattle, California longhorns, to Kamehameha in 1793. Historic documents related to the Government Homestead Program of the late 1880s indicate officials determined that goats were the only animals that were adept at grazing within arid, rocky Kaloko and Kohanaiki (Maly and Maly 2003:76, 79). Goats were present in the area prior to the late 1880s and may have been present within the project area. Limited cattle ranching was practiced at the same time, although by 1900, cattle ranching had for the most part replaced the goats (Maly and Maly 2003:75).

Post-contact animal husbandry appears to be most extensive in the southeastern portion (TMK 28) of the project area, again likely associated with nearby activity at the Huehue Ranch. The majority of the southern project area parcel is inappropriate for grazing, and most archaeological remains of animal husbandry in this area appear to be an attempt to keep cattle off the rougher *'a'ā* flows, and within the level *pāhoehoe* flow at the far *mauka* end. Other historic animal husbandry sites in the rest of the project area confirm that there was at least minimal use of this land for ranching purposes, and the large number of bulldozer roads in certain areas may be related to modern ranching activity.

Burials

There are a total of sixty-five confirmed burials at more than thirty sites. Fifty-five (85%) of these are located in TMK 26. Numerical designations given to burials by CSH are sequential for the entire Kohan 1 project (including the present project area as well as TMK: [3] 7-3-009: 017, 025 and 026), resulting in non-sequential numbers for burials within each of the four parcels. The CSH burial numbers correspond to the burial numbers reported to SHPD upon initial discovery of a burial, and therefore represent the order of discovery during the Kohan 1 project fieldwork. The numerical designations have been retained to ensure consistency between the records of initial discovery (as reported to SHPD) and discussion in the inventory survey report.

The majority of confirmed burials (with identified human remains) are located within lava tubes, which vary in size from very small to fairly large tubes. There is often a single burial per site, but in some cases there are several individuals present at the same site and/or in the same burial chamber. In most cases, there are no directly associated burial goods, although several of the burials have modification associated with them (e.g., placed rocks designating the boundary of the burial area) or possible burial items nearby (e.g., modified shell). However, there are several historic burials that do have coffins and historic artifacts associated with them (buttons, cloth fragments, etc.). Burials in lava tubes with no associated historic artifacts are generally assumed to date to the pre-contact period.

In addition to confirmed burials, there are several probable burials within the project area (no identified human remains, but strong archaeological evidence for presence of a burial). One probable burial site consists of three adjacent platforms that are consistent with Hawaiian burial platforms. Most other probable burials are located within portions of lava tubes that have been systematically and formally sealed off. These areas often involve small spaces that have been blocked with upright slabs or tightly packed cobbles. In the lower elevation portion of the project area, filled crevices on top of tumuli represent a similar type of construction that are considered probable burials.

Burials are usually located in isolated areas, and many burial sites have burial as the sole primary function. However, more than half of the burials in the project area are also associated with another primary function, most often with habitation and water collection. This association suggests either interment of the burial after the other portions of the tube were no longer used, or, less likely, contemporaneous usage of a tube for dual purposes.

Ceremonial

While ceremonial sites make up less than 2% of the total historic properties within the project area, there are several portions of the Kaloko Makai project area that utilized sites in whole or in part as a ceremonial place. Most often this is evidenced by the placement of branch coral, petroglyphs, and/or the style of construction. While these sites were certainly ceremonial areas, there are only a few that are possible *heiau*. The following is a discussion of the diagnostic attributed used to identify *heiau* and other ceremonial structures.

The general consensus regarding *heiau* (e.g. Bennett 1930, Kolb 1991, and Stokes and Dye 1991) is that they are "extraordinarily diverse" (Kolb 1991:108) and "found in a bewildering variety of forms, sizes, and locations throughout the islands" (Kirch 1985:257). W.C. Bennett's 1930 dissertation continues to be "the most comprehensive survey of heiau to date" (Kolb 1991:108). Bennett, among others, attempted to provide diagnostic attributes from which *heiau* could be identified and classified. These include size, uprights, depressions, altar, paving, tiers/terraces, coral, historical reference, location, and function.

Size refers to the surface area (i.e. square meters) of the structure. Initially, W. C. Bennett designated two size classifications for *heiau*, small and large. The dividing line between them was arbitrarily set at 50 feet "though this figure is not absolutely fixed" (Bennett 1930:4). Over the years this has been refined to include three general size ranges, small being less than 200 m², "mid-sized" (Kirch 1985:261) ranging from 200 to 400 m² and large being greater than 400 m². Based on these specifications, site -26424 (225 m²) fits into the lower end of the mid-size range. In general, mid-size structures and larger have been interpreted as religious structures (Hammatt et al 1997:181).

Attributes including altars and paving, generally refer to internal features of the structures (Hammatt et al 1997:176-177). Altar in this case is employed to describe a slightly elevated or raised stone foundation within the structure. Bennett designated altars as one of the *heiau* features focusing primarily on ethnographic evidence related to "*lele*" which he described a "a sort of scaffolding supported by posts on which offerings were laid and left to moulder away" (Bennett 1930:39). According to David Malo (1903), "In front of the lele was a pavement of pebbles (or framework) on which offerings were deposited until they were offered up, when they were laid on the lele" (Malo 1990:213-214). The term paving is employed referring to well constructed surface layer(s) of a specific structure. Although a common structural component, paving is suggestive of a "greater construction effort" (Hammatt et al 1997:185). Formal paving of two different types (slabs and *'a'ā* cobble) is evident within site -26424, as are various internal features, including a placed head branch coral.

Location refers to our perception of prominent placement of specific structures in terms of view planes from and to the particular structures (Hammatt et al 1997:189). The importance of *heiau* location has been well documented (Bennett 1930:341; Buck 1964:516; Stokes and Dye 1991:21; and Kolb 1991:80-83). When considering location (Kolb 1991):

> ...local topography of a temple was intimately tied to the concept of religious "sanctity". Large heiau were generally situated upon prominent locations such as hill tops, bluffs, or knolls. This higher ground affirms the divine and inaccessible nature of high-ranking *ali'i*, while affording an excellent view of the surrounding countryside and coast. Smaller *heiau*, on the other hand were usually placed within villages, upon mountain slopes, in upland valleys, along the coast, or in any other location that would best serve the people (Bennett 1931:35).
>
> The incorporation of the local topography makes any cursory analysis of *heiau* form suspect in two ways (Hommon 1987:24-5). First, the placement of *heiau* architectural elements tends to be influenced more by the contour of the landscape than by the abstract plan imposed upon the site by the architect. This suggests that the location of a *heiau* played a much more important role in its design than previously thought, and may partially explain the large amount of variability present in *heiau* form. Each promontory varies in its size, shape, and orientation of natural rock outcrops....
>
> Second, some platforms and terraces that appear to be solid architectural elements are actually masonry veneers, and thus are deceptive as to the amount of labor used in their construction. (Kolb 1991:82-83).

Although there are several platforms and other smaller structures in the project area that were likely shrines or had a ceremonial aspect, and some of the are possible *heiau*, there is one structure in particular that is a probable *heiau* (in TMK 28). This structure (an enclosure) has a fair amount of internal construction, formally paved floors, a placed head of branch coral, and a very formal *pāhoehoe* slab trail that leads to it. This combination of features suggests that this historic property functioned as a *heiau*. Other ceremonial features in the project area consist of platforms with some branch coral and/or multi-tiered formal construction, petroglyphs in lava tubes, and small agricultural shrines.

Habitation

Habitation sites are the most common type of historic property in the project area, and range from small lava tube shelters to multi-component complexes. The temporary and permanent habitation designation for the sites within the project area fit the models of type of habitation expected within the Intermediate and Upland Zones as well as meeting a set of criteria for interpreting modes of habitation (i.e. Cordy et al. 1991:529 and Clark 1986:198). Two specific types of habitation types – temporary (which includes shelters) and permanent - are used in the present analysis of these sites. Permanent habitation tends to increase upslope, where there are more lava tubes and better soil development for agriculture, but both temporary and permanent habitation sites are present throughout all four parcels in the project area.

The distinction between the two habitation modes is posited based on the following set of criteria, which have been developed by CSH over years doing archaeological research within the Hawaiian Islands. This includes locales where other researchers have developed models for distinguishing temporary and permanent habitation (Cordy 1981, Cordy et al. 1991 and Jensen 1988). Thus, models for distinguishing temporary versus permanent (Cordy et al. 1991, Clark 1986, Weisler and Kirch 1982, Green 1980) are available for comparative analyses.

CSH incorporates aspects of these models into the set of criteria that we then apply to the range of sites within a project area. The process of interpretation involves: 1) in field site recordation and tentative interpretations; 2) laboratory analysis that includes a) reevaluation based on inventory of all sites; b) incorporation of subsurface testing data; c) correlation to previous studies; and d) review of historic background data. In field interpretations can thus be altered based on compilation of full inventory survey data and correlations to previous studies.

The primary criteria utilized for in field interpretations include size, architecture type (e.g. lava tube, c-shape, platform, terrace, etc.) and substantiveness of architecture (i.e. substantial versus insubstantial). These three primary criteria provide essential determining factors that are found in the existing habitation models (e.g., Cordy et al. 1991:527-536, Clark 1987:105-214, Green 1980:54-63), and are discussed in detail below, with a brief summary of the correlation to sites within the project area included.

Size

While there is no set size determination to differentiate temporary and permanent habitation, structures can be roughly categorized as small (<20 m^2) or large (>20 m^2), with larger structures having a tendency to be permanent habitation. Though size can be a key determining factor there are variables which can affect its diagnostic value. These variables include differences in field and recordation methodology related to measuring and reporting on sites or features size. Examples include utilization of interior versus exterior measurements, defining natural areas or surfaces utilized for habitation (e.g. cave floor areas, modified outcrop surface area) and personal perception(s) of site or feature limits (e.g. exterior perimeters of enclosures, platforms, c-shapes, etc.). CSH utilizes maximum exterior measurements as the basis for calculating area. Thus, based on the documented size range differences and the regional variations in habitation models, as well as the above-mentioned variables Cultural Surveys Hawai'i utilizes structure size of ca. 20 m^2 as a general dividing line between large and small. The implication here is that large is suggestive of permanent habitations with small indicative of temporary habitations. However, additional criteria are necessary to affix these differing modes of habitation, especially because of variability in architecture or structure type and substantiveness of structures which size (m^2) does not address.

Architectural type

1) Temporary Habitation - lava tubes & blisters, irregular shapes, standard C- and L-shapes platforms enclosures, terraces, alignments

2) Permanent Habitation - platforms, enclosures (rectangular, square),terraces

Based on the previous habitation models as well as Cultural Surveys Hawaii's research (Hammatt et al. 1997), certain architectural or structural types tend to be more often associated with one mode of habitation or the other. Types such as C- and L-shaped enclosures, isolated hearths, caves, and modified outcrops, for example, are more often associated with temporary habitations. Platforms, rectangular enclosures and terraces are more often associated with permanent habitations. However, these architectural types are not necessarily mutually exclusive and therefore besides size, and type, substantiveness of architecture is essential in the interpretations.

Substantiveness of sites/features

1) Substantial - Well paved, bifaced, (thick) sturdy walls, volume (though no specific m^3), defined areas by alignments

2) Unsubstantial - Minimally or unmodified tubes/blisters, rough, loose paving (or none), uniface (piled versus stacked) walls, incorporated natural features.

Substantiveness of structures refers to quality of construction which in part infers amount of labor invested. Permanent habitations are expected to have more substantial architecture; such as well-paved surfaces; bi-faced, thick, sturdy walls; and in the cases of platforms and terraces, significant rock fill. In contrast, temporary habitations are expected to have less substantial architecture; such as minimally or unmodified lava tubes or blisters; rough, loose pavings; incorporation of natural features (e.g. large boulders, bedrock ledges, outcrops); and unfaced or unifaced walls. Thus the substantiveness criterion suggests mode of habitation based on perceived labor investment as an indicator of the pre-determined use of the structure. In other words, greater investment would be put into permanent habitations to provide stable and comfortable structures versus little effort invested in structures that were pre-determined for short-term or temporary use.

These three criteria: size, architecture type, and substantiveness provide the basis of CSH mode of habitation interpretations. However other criteria are viewed as necessary in supporting these interpretation. These additional criteria include: single versus multi-component site layout; internal features; functional associations and; geographic location.

Single versus Multiple Components

1) Temporary Habitation - generally single featured but multiple not all that unusual

2) Permanent Habitation - either single or multiple component but usually other feature associations.

Habitation sites are described as either single-structure site or as a complex of related multiple structures. Typically, but not exclusively, temporary habitation sites are single-structure sites or they contain only one habitation structure in a complex layout. In contrast, permanent habitation residences, although commonly containing one primary habitation structure (i.e. sleeping house), often include other function-specific structures (e.g., men's house, sleeping house and cooking house), in addition to other functional feature types that supplement a permanent household (e.g. garden areas, storage or special-use caves, and family temples).

The variation between single-structure and multiple-structure permanent residences have been described, by several 19th-century Hawaiian scholars (summarized in Cordy 1981:73-76), as being dependent on the inhabitants' social rank. The larger, multiple-structure permanent residences (containing "men's houses, sleeping houses, heiau houses, women's eating houses, houses for the storage of provisions, houses for cooking, and many other houses" [Kamakau 1976:96]) were occupied by the *ali'i* or wealthy commoners, and the single-house residences were occupied by other commoners (*maka'āinana*). Hawaiian scholar, David Malo, described a *maka'āinana* house as a "little shanty" in which all residential activities took place, "the fireplace was close to their head, and the poi dish conveniently at hand" (ibid.). Ethnographers E.S. Craighill Handy and Mary Kawena Pukui also noted the presence of single-structure households and multi-structure households, although they emphasized the multi-structure pattern (Handy and Pukui 1972:7, 112). The supposition that a multiple-house (structure) design was

common among both social classes has been demonstrated in the archaeological record (e.g. Cordy 1981; Weisler and Kirch 1982). Cultural Surveys Hawai'i's work in inland settlements, in Waiohinu, Ka'u, and Honokohau, North Kona (Robins et al. 1992 and 1995 respectively), documented that multiple-structure households were common, accounting for approximately 50% of all permanent habitation sites.

Internal features

1) Temporary Habitation - few, if any, from just survey level observation, cupboards (excavation observations, e.g. multiple hearths)

2) Permanent Habitation - cupboards, single, well-defined hearth, constructed entrances or pathways, internal alignments (indicating segregation for multiple purposes)

The presence of internal features in habitation structures tend to indicate longer or permanent use of the structure. The more common internal features associated with permanent habitation are: solitary inlaid hearths, entry ways (including constructed pathways and doorways), and alternating surfaces (tiers) or internal alignments defining different living areas. Internal features that may occur in both temporary and permanent habitation structures include cupboards, post-holes, alignments, and less substantially constructed hearths.
Observations of cultural material (midden, artifacts, manuports, etc.) at sites provide additional supportive data, however the presence or absence of such material was not a key determining criterion.

If extensive excavation of habitation sites has occurred then thickness of a site's or feature's cultural deposit and the type of associated artifacts may assist in distinguishing between temporary and permanent habitation. For example, thicker cultural deposits that contain a variety of domestic-related tools could be an indicator of permanent habitation activities (Clark 1986: 207), while sparser cultural deposits with a limited variety of tool types may be an indicator of temporary habitation activities (op.cit. 199-200). However, the density of a cultural deposit or artifact types alone does not necessarily distinguish between temporary and permanent use, since similar domestic activities - revealed by similar artifact types - may be found at both temporary and permanent habitation sites (Cordy et al. 1991:528, 533-534). In addition, a dense and thick cultural deposit may be produced at a temporary habitation site that was used frequently over a long period of time (i.e., recurrent habitation). Regardless of whether or not intact cultural deposits can indicate temporary or permanent use, not enough subsurface data was obtained, during the inventory survey of this project, to facilitate this type of comparative analysis.

Functional Associations

1) Temporary Habitation - agricultural, natural resources (lithics, mining, sources) fish/shell fish

2) Permanent Habitation - other permanent habitation, burials, religious features/sites (uprights, i.e. heiau), shrines; potable water source(s)

The functional association of other features, sites, or complexes can assist in mode of habitation interpretations. Based on previous research temporary habitations in the central Kona region tend to be associated with *mauka/makai* trails, intensive agriculture, specific resource procurement (e.g. lithics, birds, timber, etc.) and natural features such as lava tubes and/or blisters. Permanent habitations may be associated with other permanent habitations in a cluster or "village" setting, burials, religious sites/features, potable water, and ocean access (Clark 1986, Jensen 1988, Cordy

et al. 1991, Robins et al. 1995, Colin et al. 1996). Additionally, historic records related to Land Commission Awards (LCAs) are evaluated when applicable, as providing functional interpretations, possibly related to mode of habitation and thus is included in the column on "other functional associations."

Geographic location

1) Temporary Habitation - coast to inland, but more prevalent inland, amongst intensive agriculture, along trails, edges and/or interfaces of lava flows

2) Permanent Habitation - mainly coastal but scattered inland, shoreline access

Similar to other criteria previous research has documented trends pertaining to geographic location of temporary and permanent habitations. This category should be considered in regards to the topography/geology of the specific project area. The trends pertinent to the Kona region for temporary habitations indicate that sites may be found from the coast to inland, but that they are more commonly found inland, especially within an intensive agricultural context (Hammatt and Clark 1980, Robins et al. 1995). Permanent habitations are more commonly documented historically and archaeologically as being coastal with scattered inland sites. The predominance of permanent habitations being coastal is especially true for clustered housing, or "village"-like settings.

Interpretation Summary

The interpretations of habitation sites into temporary or permanent can be an uncomplicated process depending on survey area, number of sites, and type of sites present. However as can be seen in large studies, like the present survey, the quantity, variety and varying conditions of habitation sites necessitates utilization of a wide range of interpretive criteria. As explained, CSH makes in-field interpretation based on observable criteria, particular size, architectural type, and substantiveness of architecture. Other criteria are then applied as supportive data of one mode or the other. The following is a summary discussion of temporary and permanent habitations within the present project area.

Temporary and Permanent Habitation within the Project Area

Within the current project area, the majority of sites discussed as temporary habitations (or as in the case of many lava tubes, as shelters), have a floor area less than 20 m^2. In some cases where the floor area is larger, the overall site is overall informally constructed and considered temporary habitation for that reason. Specifically, lava tubes tend to be temporary habitation sites rather than permanent, but often have rather large floor spaces. Permanent habitation structures tend to be larger, often with multiple living surfaces that increase the total habitation space.

A full range of architectural types is present within the project area, including both temporary and permanent habitation platforms, enclosures, terraces, and lava tubes. Temporary habitations tended to consist of only one or just a few structures of fairly informal construction, while permanent habitation complexes often involved multiple architectural types and/or at least one formally constructed primary structure. The substantiveness of permanent habitation structures tended to be an important factor in determining the type of habitation, and is the main reason that the less formally modified lava tubes (as opposed to formally constructed surface structures) are generally considered temporary habitation.

Many of the larger habitation site complexes within the project area have internal features, in the form of hearths, storage areas, or internal alignments that suggest permanent rather than temporary habitation. Formal construction style, internal features, and multiple component features do seem to occur concurrently at permanent habitation sites within the project area, while temporary habitation tends consist of fewer features with little or no internal construction.

Finally, the distribution of the temporary habitation sites within the project does tend to be near activity areas and minor agricultural areas, whereas permanent habitation is more likely to be associated with shrines, lava tubes, and more intense agricultural modification.

Lava Tubes

Lava tubes and blisters are numerous throughout the region and - depending on a wide range of factors such as size, accessibility, and interior environmental conditions - were utilized for various functions. In the present project area these tubes are denser on the *mauka* slopes, but are present throughout all four individual TMKs. Some blisters and small tubes, inspected during the present survey, showed no evidence of utilization, but a surprisingly large number do have at least minor modification, and some lava tubes were extensively utilized for recurrent habitation. The range of functions for tubes and blisters within the project area include burial, habitation, and activity areas (specifically water collection and tool production).

While some modified lava tubes consisted of only a small blister opening and less than 5-10 square meters of usable space, other lava tubes are very large and run for hundreds of meters, often interconnecting in complex ways. Both small and large tubes were utilized, with some modification and cultural material located surprisingly far inside long lava tube systems.

Habitation-related modification in lava tubes generally consisted of floor clearing, constructed entrances, midden deposits, and signs of tool manufacture (lithic debitage, portions of fishing implements such as octopus lures, etc.). Other habitation related items include several *papamū* game boards, as well as a tapa beater and poi pounder. Habitation of lava tubes ranged from a few cleared rocks and a small amount of midden to large subsurface complexes including platforms, pavements, walls, and petroglyphs.

Other than habitation, the two other primary functions for lava tubes in the project area are burial and water collection. A large percentage of the burials in the project area are located inside lava tubes, and are interred utilizing various styles. Some lava tube burials within the project area are historic (associated with historic goods and/or coffins) but most have no associated grave goods and are assumed to be pre-contact. It is notable that many of the burials located during the inventory survey were far from entrances and/or in difficult to reach locations, sometimes due to the main entrance to the burial chamber being intentionally blocked.

Water collection in lava tubes is also quite frequent, especially in the *mauka* regions of the project area. Small informal concentrations of cobbles and small boulders in lava tubes are indicative of water collection activity areas. Generally water catchment features consist of small to medium sized cobbles placed in rough circles or stacked against outcrops in tubes to create a stable area for some sort of container (gourds or carved wood). Some sites in the project area have more formal water collection features, which are often rectangular in shape and larger than the less obvious informal water catchments. Many water catchment lava tubes have a fair amount of internal construction, such as formally modified entrances which appear to constrict the tube entrances (possibly for moisture retention) as well as making movement through the tube easier.

Other associated features include small cairns in the lava tube, which appear to direct a person to tube exits.

While no gourds were found in place in the project area - or any other containers such as wooden bowls or carved logs - occasionally gourd fragments were found. In more intensive water collection lava tubes, there is often charcoal associated with water collection features, which can sometimes be identified as charred *kukui* nut; the *kukui* nuts (also known as candle nut) were almost certainly used as a light source during collection of water vessels. Both gourd fragments and charcoal associated with water collection are good candidates for radiocarbon dating during data recovery.

The story of Ko'amokumokuohe'eia and historic newspaper articles translated by Kepa Maly (see above Background Research section) suggest that water collection was very important in the Kekaha region, and the two formal water collection sites mentioned above appear to fit very closely with the type of activity described in these accounts. Differences in the size and formality of water collection features may be attributable to varying sizes of containers used, i.e., gourds versus carved trees.

Lava tubes also generally offer a greater degree of midden and artifact preservation compared to surface sites. Of the more than fifty indigenous artifacts found during the inventory survey (including lithics, abraders, bone awls, manuports, a poi pounder, a tapa beater, *papamū* boards, etc.), the vast majority were observed in lava tubes. Although most lava tubes in the project area contain a minimal amount of soil deposition, there is high potential for data recovery of the surface midden present, as well as recovering datable charcoal and wood/gourd fragments associated with water collection features. Overall, lava tube utilization within the project area was likely an important factor in settlement patterns and site distribution.

Trails

Trails are a common site type within the Kekaha region in general and one of the more prevalent types specific to the Intermediate Zone. Although some of the trails in the project area were little more than remnants, several run many hundreds of meters and are in good to excellent condition. The most common type of trail consists of *pāhoehoe* slabs placed stepping distance apart on *'a'ā*; these trails range from remnants (only a few slabs) to a trail that consists of immediately adjacent *pāhoehoe* slabs for several hundred meters. *Pāhoehoe* slab trails are generally considered to be pre-contact. Historic trails, of which there are a few in the project area, tend to be wider and have curbing and causeways (typical of historic horse trails).

The intersection of three of the trails in TMK 28 (one very formal *pāhoehoe* slab trail, one informal slab and crushed *'a'ā* trail, and a historic curbed horse trail) is especially of interest, as it appears to represent trail use during subsequent periods of time. The construction type also is indicative of changing needs in transportation, specifically the creation of trails more amenable to travel by horse or other pack animal.

Another long historic trail is located in the north east portion of the project area (TMK 26). Site -10714 is a wide, curbstone trail over *pāhoehoe* that utilizes constructed causeways to cross low-lying areas in the flow. This trail matched well with "Kohanaiki Road" seen on Emerson's maps dating to around 1888, and was also found in the Wolforth (2005) study area directly *mauka* of the current project area. This trail is associated with several large habitation sites, as well as the Kona Field System.

The large number of trails within the project area reveal that the residents of Kaloko and Kohanaiki (both pre- and post-contact) had a significant network of travel routes that provided access to resources and exchange of resources over the *'a'ā* (especially in TMK 17 and TMK 25). The presence of several different types of trails as well as intersecting/overlapping trails suggests use of this area over various periods of time. The trail network includes both *mauka/makai* and cross slope-oriented trails, and the trails thus provide fairly direct coast-to-uplands routes via the project area and access to activity areas within the project area. The activity areas include: agricultural pursuits, ceremonial sites, and temporary and recurrent habitation sites, as well as animal husbandry areas. Overall the trails suggest a high level of energy investment in constructing paths for traversing the *'a'ā* flow, both in pre-contact times as well as historically.

Attempts were made with all trails in the project area to follow them to their full extent and where possible make relevant correlations. It proved impossible to follow some trails on the grass-covered *pāhoehoe* adjacent to the *'a'ā* lava where the trails were still visible. The uniformity of the terrain (usually consisting of undulating *pāhoehoe*) surrounding the *'a'ā* flows negates the necessity of extensive trail construction and suggests that while the trails followed a single route over the *'a'ā* flows, once the trail exited the *'a'ā* more than one path may have been traversed by travelers. Additionally, grass and *koa haole* growth is thickest on the *pāhoehoe* terrain; this, in combination with the lack of trail structure, makes identifying specific trail alignments on the *pāhoehoe* lava essentially impossible.

Site Distribution

Overall, the site/feature types and functions observed during the inventory survey correlate with the anticipated finds for the Intermediate and Upland Zone of the Kekaha region in which the project area lies. Historic properties within the project area include agricultural modification, permanent and temporary habitation complexes, a large number of lava tube sites (including tubes used for habitation, water collection, burial, and ceremonial activity), historic animal husbandry, and several intact trail systems. Most habitation sites have been interpreted as temporary in nature, with permanent habitation sites increasing in density significantly in the *mauka* portions of the project area. Agricultural sites/features are present in increasing density on the *mauka* slopes where the Kona Field System begins in earnest; lower elevation agricultural modifications represent opportunistic productivity versus the type of full scale land modification for intensive productivity at higher elevations. Several long trails traverse various portions of the project area and are both historic and pre-contact in style. Finally, burials are most commonly found in lava tubes and the majority are located within the northeastern parcel, TMK 26. Overall, the majority of the recorded sites in the project area are presumed to be pre-contact, with some historic period activity. Based on historic information, goat and cattle and grazing was the main form of land use during the historic to modern era, although there are a few historic homestead sites present, as well as historic burials.

Site distribution clearly indicates a preference for permanent habitation in the *mauka* portion of the project area, most notably in the northeastern parcel (TMK 26). There are fairly distinct differences between Kaloko and Kohanaiki Ahupua'a site density; very possibly due to ranching activity and bulldozing disturbing much of the Kaloko portions of the *ahupua'a*. The site density in Kohanaiki is especially high in TMK 25 and 26. Probably most surprising is the large number of sites in TMK 25, and large amount of widespread temporary habitation in what is generally

thought of as a "barren" land. The increased amount of habitation on the *mauka* slopes (eastern portion of TMK 26) is less surprising, as this is a common pattern for this area, although this makes the numerous site complexes no less impressive. The lava tube density in TMK 26 is also quite impressive, with nearly every lava tube encountered having at least minor cultural modification, and lava tube sites ranging from small shelters to high energy-investment permanent habitation complexes. Water collection in this parcel is also quite remarkable, with the number of total water catchment features numbering in the hundreds, if not thousands for the entire Kaloko Makai project area, with the majority located in TMK 26.

Geologically, the large south parcel (TMK 28) is largely barren *'a'ā* with very low site density (approximately 0.11 sites/acre); relatively level pāhoehoe areas in the *mauka* section of the parcel were more heavily utilized in the past but there does appear to be disturbance of older sites from historic and modern ranching activity. It is notable that the majority of sites in this parcel 28 (and within the Kaloko Ahupua'a portions of the project area in general) are either lava tubes or located on high outcrops/tumuli. This undoubtedly is in part due to the advantages of these locations for habitation (shade, cool breeze, good views, etc.), but it is also hypothesized that bulldozing and ranching activity could also be responsible for the lack of intact surface structures in this area. In TMK 28, the most notable sites include a more than 500 meter long formally constructed *pāhoehoe* slab trail that leads to a ceremonial enclosure (probable *heiau*) at the edge of the *'a'ā* flow. There is also a series of three large burial platforms in the northeastern corner of this parcel.

The northern *makai* parcel, TMK 17, also has fairly low site density relative to the *mauka* parcels (0.26 aites/acre). This is not unexpected given the rough *pāhoehoe* and *'a'ā* that dominate this area, with little access to water and generally very rough conditions. About 20% of the sites in this parcel consist of *mauka/makai* trails (mostly *pāhoehoe* slab stepping stone trails) running across *'a'ā* flows. An unusual aspect of this set of trails is their proximity to the *ahupua'a* boundary, suggesting that there was substantive traffic between Kohanaiki and Kaloko Ahupua'a in this area. There is a noticeable concentration of surface sites that runs from the center of the project area up a moderate *pāhoehoe* ridge that ends at a foot of a very prominent, tall *'a'ā* flow near the *mauka* boundary of the project area. Due to the height of this *'a'ā* flow, there are many sites here, including some over the boundary of the project area.This parcel also has a fairly large number of modified outcrops and enclosures, which mainly function as intermittent (temporary) places for habitation. Most temporary habitation sites are located near identifiable or inferred transportation routes, and sites generally are most frequent on ridges and tumuli, or in lava tubes. In this way, the dense sites along the 120 foot contour and the other distinct ridges are expected. Lava tubes are relatively rare in this parcel, adding to the difficulty of water procurement, and this portion of the project area fits the model for the Intermediate Zone (Cordy 1991) very well.

Immediately *mauka* of parcel 17, site density begins to increase in TMK 25, with 0.34 sites/acre. Habitation (both temporary and permanent) site density increases, with more formal and larger habitation complexes in the east portion of the parcel. Notably, there was considerably more habitation sites than was expected given that most of the parcel is within the "Intermediate Zone" (Cordy 1991). In general, there is a clear preference of *pāhoehoe* terrain over *'a'ā* terrain in terms of site location. The *'a'ā* tends to display features such as trails, habitation, and storage sites and generally the elevated flows likely create separation and distinction for certain ceremonial sites. Because many of the sites are close together, it seems reasonable to conclude that many, though probably not all, the structures were in use contemporaneously. If not used

contemporaneously in this area, it is difficult to understand why so many enclosures were constructed, instead of modifying existing structures. Interestingly, the number of enclosures in Kohanaiki is in sharp contrast to Kaloko, with several permanent habitation sites and the relatively dense area of habitation around the top of Huliko'a Drive (in Kohanaiki). Though there are few lava tubes to collect water in, the intensive agricultural site near the northern edge of the project area is the best evidence that many of these Kohanaiki habitations were well populated. It stands to reason that it is likely that several families lived seasonally in the area, perhaps more often. It also seems likely that survivors of disease epidemics after contact made the shortest move possible, to the Kohanaiki Homesteads established along the government road (Māmalahoa Highway) 2.4 kilometers or 1.4 miles directly upslope.

The northeastern (*mauka*) parcel, TMK 26, has by far the highest site density (0.62 sites/acre). This area is characterized by large expanses of *pāhoehoe*, an increased amount of soil development and rain fall, and an increase in the size and number of lava tubes. While the west portion of the parcel is similar in site density and in character to TMK 25, the eastern upland portion has a very steep increase in site density and the number of large site complexes. The site complexes tend to have multiple features (note that 43% of all features from the entire project area are located within this parcel, despite it being the smallest in acreage) and sites are more commonly formal than in the other three parcels. There is an increase in the number and size of permanent habitation complexes and an increase in intensity of lava tube utilization. Water collection within lava tubes is ubiquitous, as is low-intensity agriculture throughout the parcel. On the *mauka* slopes of the project area agriculture increases greatly in intensity and becomes more formal; this area is considered a portion of the Kona Field System and was recorded as a portion of that large agricultural complex. This parcel also has a fairly formal trail running *mauka/makai*; this trail appears to match Emerson's historic maps that refer to it as "Kohanaiki Road" (see trails discussion above). Other notable sites include several ceremonial structures and petroglyph panels; some of the ceremonial structures are probable *heiau*. Finally, burials are also very common within this parcel, most often located within lava tubes, although several surface structures have also been determined to be burial platforms. Burials are often single individuals, but some tubes were clearly being utilized as burial tombs, and burials range from pre-contact to historic. Many burials are located far from any tube entrance, and this issue will need to be fully addressed in preservation and burial treatment plans.

Conclusions

Kohanaiki and Kaloko, based on the present research, had fairly different in resources at the elevation of the project area, and varied significantly in the types of resources as elevation increased. Rainfall, eroded *pāhoehoe* preferable for agriculture, and barren *'a'ā* all created distinct landscapes for these *ahupua'a* in the project area. Both had numerous lava tubes a great resource in this arid region. In Kohanaiki the *mauka* regions had greater potential for agriculture and had very dense lava tubes, attracting habitation to this area.

As a whole, inhabitants of Kohanaiki and Kaloko were fairly spread out, but were more concentrated along the upper half of the project area. Pre-contact times there could have been as many as a dozen households living in this more *mauka* area. As has been demonstrated elsewhere in Kona, strong preference was given to ridges, small rises and proximity to lava tubes in the case of most of these habitations. This habitation area in the project area was most likely the *makai* edge of an inland population center, that likely extended *mauka* of the Kohanaiki

Homesteads. In post-contact times, it is likely that many of those who remained resettled near the new government road, at the Kohanaiki Homesteads or in the land claims awarded in this vicinity. Still, findings show that the area continued to be an important resource and habitation area evidenced by a notable number of historic sites including a habitation, platforms, two curb stone trails, a historic habitation and numerous historic burials. In these post-contact times, the mauka project area probably served as an informal extension to the Kohanaiki Homesteads to the *makai*.

Residents of these areas were industrious and opportunistic use of the natural terrain and natural resources is evident. The lack of readily available freshwater led to a number of adjustments in living practices. Agricultural areas are concentrated higher up the slope where rainfall is more prevalent. Lava tubes were utilized to capture dripping ground water almost without exception, even when the labor required to do so would have been very significant. Habitation was also somewhat intensive, with dense complexes of structures located further *makai* than might have been expected by previous work in the area. These areas were interdependent with other portions of the *ahupua'a*. Presence of significant marine food remains in *mauka* agricultural areas and habitations reinforce the importance of coastal resources here. The *makai* project area was probably frequently traversed on *mauka-makai* trails, which were identified to some degree in the project area and have been identified in Kaloko-Honōkohau National Historic Park to the west. Interestingly, evidence was found that Kaloko and Kohanaiki may have been interdependent upon eachother at these elevations, perhaps more than with other neighboring *ahupua'a*. Dense clusters of trails crossing *'a'ā* flows in both the *makai* project area (TMK 17) and the middle project area (the center of TMK 25) virtually straddle the presently known *ahupua'a* boundary. Also, historic maps show that the major *mauka-makai* trail, Site -10714, crossed from Kohanaiki into Kaloko in the middle project area, though this was not definitively confirmed with archaeological findings. At least one possible crossing preserved as a gap in the post-contact *ahupua'a* wall was also located near the *mauka* end of the project area.

Until the construction of Queen Ka'ahumanu Highway, the use of some of these trails likely continued for access to the coast. Other historic use, in particular ranching, played a major role in a continually evolving landscape. Huehue ranch provided jobs for paniolo who continued utilize the area, introduced fodder flora have overtaken much of the landscape and grazing and mechanical clearing have likely negatively impacted many sites. Modern use has continued to affect the area and disturbance in the form of bulldozing, dumping and camp sites along Hina Lani Street have had the greatest impact.

Nevertheless, these numerous stages of land use have had a large area to share, and much of the earliest land use in pre-contact times is still in good condition. Further research on these cultural resources through a comprehensive data recovery program will add considerably to this knowledge. Preservation will also be a major consideration especially in the northeast project area with emphasis on trails, burials and sites of high interpretive value.

PROJECT EFFECT AND MITIGATION RECOMMENDATIONS

Project Effect

The proposed project will affect historic properties recommended eligible to the Hawai'i Register. CSH's project specific effect recommendation is "effect, with agreed upon mitigation measures."

Historic properties outside of the project area do have the potential to be affected by the current development. The proximity of the project area to Kaloko-Honokōhau National Historical Park to the east is the primary concern. Historic properties north and south of the project area are of less concern due to the extensive industrial/commercial developments separating the project area from the potential sites there. Also of some concern are the remaining Kohanaiki Homsteads in the next parcel east of the project area. Three of these homesteads were recommended for preservation by previous archaeological work there (Wolforth 2005) and if not directly affected by development of that parcel, their viewplane has the potential to be affected by development of the project area.

In the case of the National Historical Park, there is potential visual impact by further development of the slopes of Hualālai and potential auditory impact due to increased use and/or expansion of Queen Ka'ahumanu Highway and/or Hina-Lani Street. In both cases, significant impact has already been made by large industrial/commercial developments *mauka* of Queen Ka'ahumanu Highway. However, due to the situation of the project area on the slope immediately overlooking the park, there is a potential cumulative effect.

Mitigation Recommendations

Overall, the project area contains a large number of significant sites that are recommended for preservation and/or data recovery. It is recommended that of the 341 sites in the project area, a total of eighty (80) sites be subjected to a program of data recovery to address scientific and informational concerns and a total of seventy-two (72) sites be preserved (Table 11). Preservation sites should be considered for some amount of data recovery effort as part of the preservation plan, to include further photographic documentation, dating, etc. as appropriate. It is believed that continued documentation in some cases could help mitigate possible vandalism or looting of preserve areas.

The remaining 189 sites are not recommended to undergo further research, as the documentation and plotting of location during the current study has addressed the limited information available at these sites. These sites are classified under Criterion D significance only and are generally characterized as sites in poor structural condition, or sites such as minimally modified lava tubes, trail remnants, agricultural features, or animal husbandry walls that lack excavation potential.

Mitigation for impact on historic properties outside the project area is best addressed by architectural and landscaping measures to minimize visual impact on the environment in Kaloko-Honokōhau National Historical Park. Based on previous development of the vicinity, tall buildings directly adjacent to the highway, bright or light colored paint, heavy use of corrugated metal and landscaping using non-native plants would have the greatest visual impact on those properties in the park. Use of low-rise architecture, local stone, muted colors and native plants

would be preferable from a mitigation perspective and would minimize the urban feel of the land most immediately visible from, and historically tied to, that preserved in the park.

Table 11. Mitigation measures recommended for each parcel

Recommendation	TMK 17		TMK 25		TMK 26		TMK 28		All 4 TMKs	
	No.	%	No.	%	No.	%	No.	%	No.	%
Preservation	3	5.1	18	14.9	38	30.8	13	31.7	**72**	**21**
Data Recovery	19	32.2	29	24.0	23	19.2	8	19.5	**80**	**23**
No Further Work	37	62.7	74	61.2	60	50.0	20	48.8	**189**	**56**
Total (total %)	**59 (17%)**		**121 (36%)**		**120 (35%)**		**41 (12%)**		**341 (100%)**	

Data Recovery

A total of eighty (80) sites are slated for data recovery and should be subjected to further documentation and, if feasible, excavation to address scientific and information interests. Data recovery should proceed in accordance with a data recovery plan that is to be submitted to DLNR State Historic Preservation Division for review and approval.

The sites selected for data recovery include a variety of site and function types attributable to traditional Hawaiian use. Functional types include habitation (temporary and permanent), agricultural areas, trails, activity areas (i.e., water collection in lava tubes), and sites deemed to have good excavation potential. The majority of sites slated for data recovery are those sites with the most formal construction and/or the largest cultural deposits. In this project area this results in a close focus on habitation (both temporary and permanent), both in lava tubes and on the surface.

Potential research topics that further documentation could answer should be explored in the data recovery plan. At this time it is recommended that further consideration be given to research topics such as those listed below, as well as any pertinent questions raised by contemporary research on the island, or in comparable environments elsewhere in the Pacific region. One lava tube within the project area contains some potentially significant paleoenvironmental remains that should also be considered during data recovery. Further, the plan should consider numerous new technologies entering the field of archaeology that could answer new types of questions.

Possible Data Recovery Topics:

(1) An evaluation of historic property distribution as it compares to common settlement models (e.g., Schilt 1984; Kirch 1985; and Cordy et al. 1991). That is, were Kohanaiki and Kaloko exceptions to these models or do they confirm their veracity? In addition, historic versus pre-contact settlement patterns could be addressed.

(2) Further study of the use of permanent and temporary habitation sites in the upland zone to include further functional interpretation and analysis of greater quantities of

midden for subsistence patterns in the area. Results could be compared with other habitation models (e.g. Cordy et al. 1991; Mitchell and Kolb 1992; and Hammatt et al. 1995).

(3) To a limited degree, habitation research may collect data with potential to provide some insight into social dynamics in both *ahupua'a* through a comparison with Dr. Ross Cordy's 1991 model of social rank determinants in coastal Kaloko and Honokōhau I and II *ahupua'a*. There are several large habitation complexes within the project area that include ceremonial components, and these aspects could be more thoroughly addressed.

(4) Water collection within lava tubes is a frequent activity throughout the project area, and site distribution appears to be partially dependent on this resource. Thus, a focus on the distribution and chronology of this particular resource and its relationship to habitation is recommended.

(5) Assessment of the suitability of non-radiometric dating of structures and/or trails, such as TL/OSL.

(6) Higher quality digital photographic documentation.

Although the eighty sites designated for data recovery can be wholly or partially mitigated through this measure, these historic properties may have a valuable aspect for the proposed residential neighborhood, and interim preservation is an alternate consideration. These sites speak to the history of the locale, creating a uniqueness that cannot be engineered into an urban area. One option is to voluntarily preserve these habitation sites on lots that would appeal to home owners who are interested in history and would perceive this as value added to their property. The recommendation would thus be interim preservation with an option to pursue data recovery at the landowner's discretion.

Site Preservation

There are a total of seventy-two (72) sites in the project area that are recommended for preservation in whole or in part. A large percentage of these sites are recommended for preservation based on the presence of a burial (confirmed or probable) and/or association with a burial. Burials are especially common in lava tubes within the project area and special consideration will need to be given to the preservation in place of burials, especially when remains are located far from the lava tube entrances. Thus, the preservation plan will need to address the logistics of preservation boundaries in terms of accurate locational information as well as how to preserve/seal entrances associated with burials. Several of the non-burial preserve sites are major intact trail systems that run for several hundred meters, and two sites are *ahupua'a* walls that are recommended for preservation with breaches allowed. Other preserve sites include ceremonial enclosures and platforms (possible *heiau*), excellent examples of habitation complexes (some of which utilize both surface and sub-surface areas), and a few petroglyph panels.

It is recommended that considerations for the preservation of these sites be detailed in a burial treatment plan and preservation plan to be approved by the State Historic Preservation Division.

Disposition of Materials

The complete collection of artifacts associated with this archaeological inventory survey was collected from private lands; accordingly, this material belongs to the landowner. While a relatively small number of artifacts were collected given the size of the project, some items were retrieved during the inventory survey due to concern over possible looting. Some artifacts and midden were collected as part of the test excavations conducted. The artifacts associated with this archaeological inventory survey will be temporarily housed at a CSH storage facility. CSH will make arrangements with the landowner regarding the disposition of the project's collection. Should the landowner request archiving of material, then the archive location will be determined in consultation with SHPD.

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Appendix K

Archaeological Assessment Report for the Proposed Kaloko Heights Well Site Project
Cultural Surveys Hawaii, Inc.
July 2011

Draft
Archaeological Assessment Report
For the Proposed Kaloko Heights Well Site Project, Kaloko Ahupua'a, North Kona District, Hawai'i Island
TMK: [3] 7-3-009:019 por.

Prepared for

Stanford Carr Development

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Management Summary

Reference	Archaeological Assessment Report For the Proposed Kaloko Heights Well Site Project, Kaloko Ahupua'a, North Kona District, Hawai'i Island, TMK: [3] 7-3-009:019 por. (Wilkinson et al. 2011)
Date	July 2011
Project Number (s)	Cultural Surveys Hawai'i, Inc. (CSH) Project Code: KALOKO 7
Investigation Permit Number	The fieldwork component of the archaeological assessment was carried out under archaeological permit # 11-17 issued by the Hawai'i State Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawai'i Administrative Rules (HAR) Chapter 13-282
Project Location	The current project area consists of an approximately 1,500-foot long by 100-foot wide corridor situated between 950 and 1050 feet amsl on the western slope of Hualālai. The project area is adjacent to the southern side of Hina Lani Street, and is bounded by the Kona Heavens housing subdivision to the east and undeveloped land to the south and west. (Figure 1 through Figure 3)
Land Jurisdiction	Private
Agencies	Department of Land and Natural Resources / State Historic Preservation Division (DLNR / SHPD)
Project Description	The proposed project would include the drilling of an exploratory well. The current archaeological study will help to identify the most appropriate location for placement of the well.
Project Acreage	Approximately 3.44 acres
Area of Potential Effect (APE)	For the purposes of the current archaeological assessment, the APE is defined as the entire, approximately 3.44-acre, project area, as the specific APE within the overall project area is presently undetermined.
Historic Preservation Regulatory Context	This document was prepared to support the proposed project's historic preservation review under Hawai'i Revised Statutes (HRS) Chapter 6E-8/42 and Hawai'i Administrative Rules (HAR) Chapter 13-13-275/284. In consultation with the Hawai'i State Historic Preservation Division (SHPD), the current investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR Chapter 13-13-276.
Fieldwork Effort	The fieldwork component of this archaeological assessment was accomplished on July 5, 2011 by CSH archaeologists Johnny Dudoit, B.A. and Olivier Bautista, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. (principal investigator). The fieldwork required approximately two person-days to complete.
Number of Historic Properties Identified	None

Effect Recommendation	No historic properties were identified within the approximately 3.44-acre project area. Mechanical clearing related to the operations of Huehue Ranch and the construction of the Kona Heavens subdivision likely destroyed or severely impacted any surface historic properties that may have existed within the project area. Consequently, CSH's effect recommendation for the proposed project is "no historic properties affected." While no surface historic properties were identified during the current investigation, the potential for subsurface features (in particular, modified lava tubes) still remains. Modifications can occur deep in lava tubes that may not have openings to the surface within the bounds of the project area.
Mitigation Recommendation	No historic preservation mitigation measures are recommended for the proposed project and no further archaeological work is warranted. In the unlikely event that cultural deposits, lava tubes or human remains are encountered during the course of project-related ground disturbance, all work in the immediate area should stop and SHPD/ DLNR should be promptly notified.

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Section 1 Introduction

1.1 Project Background

At the request of Stanford Carr Development, Cultural Surveys Hawai'i (CSH) conducted an archaeological assessment of the proposed Kaloko Heights well site, in the *ahupua'a* (traditional land division) of Kaloko, North Kona District, on the Island of Hawai'i, TMK: [3] 7-3-009:019 (portion). The approximately 3.44-acre project area is depicted on the 1996 Kailua U.S. Geological Survey 7.5-minute topographic quadrangle (Figure 1), tax map (Figure 2), and aerial photograph (Figure 3).

The current project area consists of an approximately 1,500-foot long by 100-foot wide corridor situated on the western slope of Hualālai. The project area is adjacent to the southern side of Hina Lani Street, and is bounded by the Kona Heavens housing subdivision to the east and undeveloped land to the south and west. The proposed project would include the drilling of an exploratory well. The current archaeological study will help to identify the most appropriate location for placement of the well.

Under Hawai'i state historic preservation legislation, archaeological inventory surveys are designed to identify, document, and provide significance and mitigation recommendations for historic properties. Under this legislation, historic properties are defined as any "building, structure, object, district, area, or site, including *heiau* [traditional place of worship] and underwater site, which is over fifty years old." A project's effect and potential mitigation measures are evaluated based on the project's potential impact to "significant" historic properties (those historic properties determined eligible, based on established significance criteria, for inclusion in the Hawai'i Register of Historic Places [Hawai'i Register]). Determinations of eligibility to the Hawai'i Register result when a state agency official's historic property "significance assessment" is approved by the State Historic Preservation Division/Department of Land and Natural Recourses (SHPD / DLNR), or when SHPD / DLNR itself makes an eligibility determination for an historic property (HAR Chapter 13-284).

In consultation with SHPD, this inventory survey investigation was designed to fulfill the state requirements for archaeological inventory surveys (HAR Chapter 13-276).

1.2 Scope of Work

The following archaeological inventory survey (AIS) scope of work is designed to satisfy the Hawai'i state requirements for archaeological inventory surveys (Hawai'i Administrative Rules [HAR] Chapter 13-276 and Chapter 13-275/284):

1. Historic and archaeological background research, including a search of historic maps, written records, Land Commission Award documents, and the reports from prior archaeological investigations. This research will focus on the specific project area's past land use, with general background on the pre-contact and historic settlement patterns of the *ahupua'a* and district. This background information will be used to compile a predictive model for the types and locations of historic properties that could be expected within the project area.

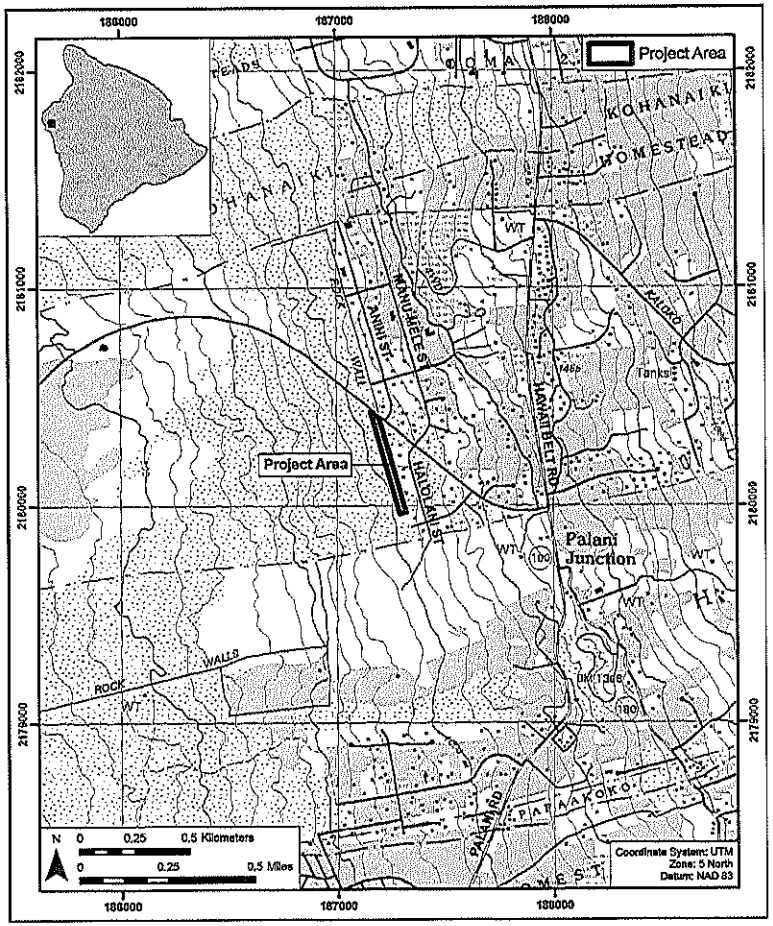

Figure 1. Portion of the 1996 U.S. Geological Survey 7.5' topographic map (Kailua Quadrangle), showing the location of the project area

Figure 3. Aerial photo (GeoEye 2001) showing the location of the project area

Figure 2. Tax Map Key [3] 7-3-009, showing the location of the project area along the eastern side of parcel 019

2. A complete (100%) systematic pedestrian inspection of the project area to identify any potential surface historic properties. Surface historic properties will be recorded with an evaluation of age, function, interrelationships, and significance. Documentation will include photographs, scale drawings, and, if warranted, limited controlled excavation of select sites and/or features.
3. As appropriate, consultation with knowledgeable individuals regarding the project area's history, past land use, and the function and age of the historic properties documented within the project area.
4. As appropriate, laboratory work to process and gather relevant environmental and/or archaeological information from collected samples.
5. Preparation of an inventory survey report, which will include the following:
   a) A project description;
   b) A section of a U.S. Geological Survey topographic map showing the project area boundaries and the location of all recorded historic properties;
   c) Historical and archaeological background sections summarizing prehistoric and historic land use of the project area and its vicinity;
   d) Descriptions of all historic properties, including selected photographs, scale drawings, and discussions of age, function, laboratory results, and significance, per the requirements of HAR 13-276. Each historic property will be assigned a Hawai'i State Inventory of Historic Properties number;
   e) If appropriate, a section concerning cultural consultations [per the requirements of HAR 13-276-5(g) and HAR 13-275/284-8(a) (2)];
   f) A summary of historic property categories, integrity, and significance based upon the Hawai'i Register of Historic Places criteria;
   g) A project effect recommendation;
   h) Treatment recommendations to mitigate the project's adverse effect on any historic properties identified in the project area that are recommended eligible to the Hawai'i Register of Historic Places.

This scope of work includes full coordination with the SHPD/DLNR 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 in the North Kona District of Hawai'i Island, at an elevation ranging from approximately between 950 and 1050 feet amsl. Kona weather is typified by afternoon showers brought on by warm air which has been moved inland by light sea breezes. The humid air gradually condenses over higher altitudes throughout the day. At night the land

cools resulting in breezes which send warm air back out to sea. Rainfall in the vicinity of the current project area averages between 30 and 40 inches per year (Armstrong 1973:57).

The ground surface within the project area generally slopes slightly to the west-southwest, with a moderate slope along the southern end of the project area. The soils comprising the project area consist entirely of Punaluu extremely rocky peat with 6 to 20 percent slopes (Sato et al. 1973, Figure 4). This well-drained, thin organic soil type is found overlying *pāhoehoe* (smooth lava) bedrock, and bedrock outcrops are common. This soil is typically used for pasture (Sato et al. 1973:48).

The project area is heavily forested (Figure 5). Non-native *koa haole* (*Leucanena glauca*) is present in dense thickets adjacent to Hina Lani Street. Other predominant alien plant species include Christmasberry *(Schinus terebinthifolius)*, guinea grass (*Urochloa maxima*) and other grasses, assorted vines including *lilikoi* (*Passiflora edulis*), and lantana (*Lantana camara*). Macadamia nut (*Macadamia integrifolia*), castor bean (*Ricinus communis*), bitter melon (*Momordica charantia*), coconut (*Cocos nucifera*), and ivy gourd (*Coccinia grandis*) were observed sporadically, and may have been planted by residents of the Kona Heavens subdivision or by the excrement of animals such as feral pigs. Native plants observed in the project area include *kukui* (*Aleurites moluccana*) and *alahe'e* (Psydrax odorata).

1.3.2 Built Environment

The project area is bounded by Hina Lani Street to the north, while developed and landscaped residential lots are present along the eastern project boundary; the lands immediately south and west are currently undeveloped (see Figure 3). The project area and adjacent undeveloped lands were completely cleared for pasturage, possibly by chain-dragging, during the mid-20th century. During the 1970s portions of the project area were impacted during the initial phases of construction for the Kona Heavens subdivision. This history of ground disturbance may have served to "level" portions of the project area.

An historic rock wall is depicted on the modern USGS topographic map (see Figure 1) directly across from the project area extending north from Hina Lani Street, and corresponds with State Inventory of Historic Places (SIHP) No. 10710 (see Section 3.2.1).

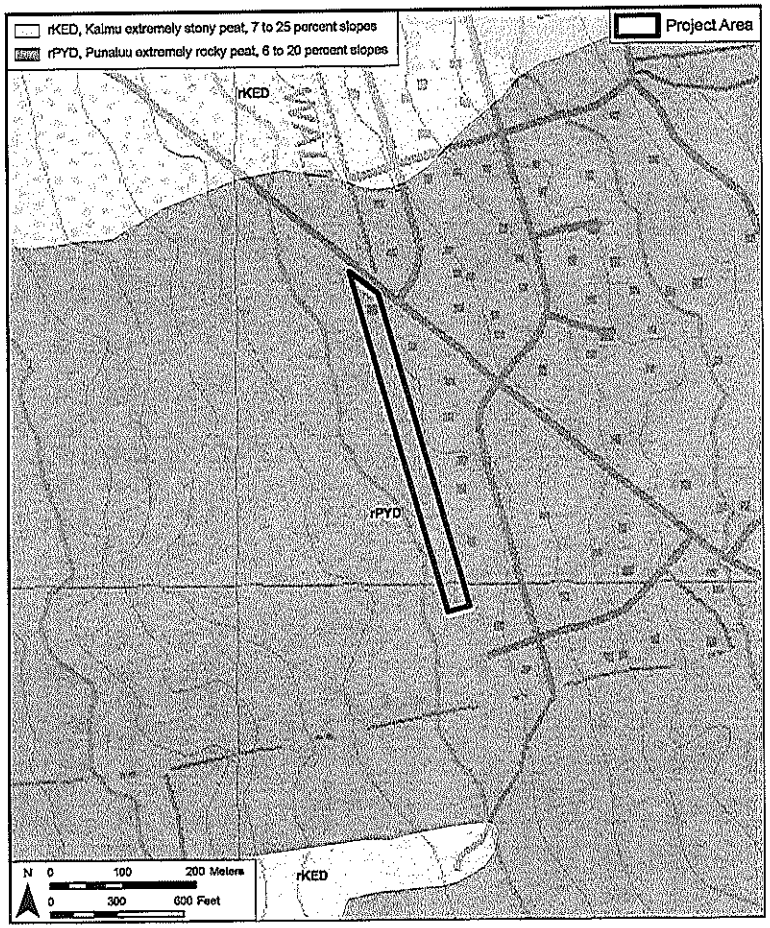

Figure 4. Portion of the 1996 USGS 7.5' topographic map (Kailua Quadrangle) overlain with USDA soil survey data (Sato et al. 1973), showing project area soils

Figure 5. Photo of the typically dense vegetation encountered in the current project area; view to the southwest

Section 2 Methods

2.1 Field Methods

The fieldwork component of the archaeological inventory survey investigation was carried out under archaeological research permit number 11-17, issued by the Hawai'i State Historic Preservation Division / Department of Land and Natural Resources (SHPD / DLNR), per Hawai'i Administrative Rules (HAR) Chapter 13-13-282. The fieldwork component of this archaeological inventory survey was accomplished on July 5, 2011 by CSH archaeologists Johnny Dudoit, B.A. and Olivier Bautista, B.A. under the general supervision of Hallett H. Hammatt, PhD (principal investigator). The fieldwork required approximately two person-days to complete.

A pedestrian ground survey of the project area was undertaken for the purpose of historic property identification and documentation. The ground survey of the project area was accomplished through systematic sweeps, and provided complete (100%) coverage of the project area. The interval between the archaeologists was generally between five to ten meters (m), depending on the density of vegetation.

All historic properties encountered during the survey fieldwork were to be documented through detailed written description, with evaluation of function, interrelationships, and significance; photographs; scale drawings using standard tape-and-compass mapping procedures; and located with a Garmin GPSMAP60Cx unit (accuracy +/- 2-5 m).

2.2 Laboratory Methods

No cultural material was observed or collected during this project, therefore laboratory studies were unnecessary.

2.3 Document Review

Background research included a review of previous archaeological studies on file at SHPD; review of documents at Hamilton Library of the University of Hawai'i at Mānoa, the Hawai'i State Archives, the Mission Houses Museum Library, the Hawai'i Public Library, and the Archives of the Bishop Museum; study of historic photographs at the Hawai'i State Archives and the Archives of the Bishop Museum; and study of historic maps at the Survey Office of the Department of Land and Natural Resources. Historic maps and photographs from the CSH library were also consulted. In addition, Māhele records were examined from the Waihona 'Aina database (<www.waihona.com>).

Section 3 Background Research

This section provides an overview of the traditional and historical background of the region in which the current project area is situated, as well as an analysis of previous archaeological studies conducted in the vicinity. This background information is then summarized and used to produce a predictive model presenting the types of sites that might be encountered within the project area.

3.1 Traditional and Historical Background

3.1.1 Mythological and Traditional Accounts

The *ahupua'a* of Kaloko lies at the southern end of Kekaha, the portion of North Kona extending from Honokōhau to 'Anaeho'omalu. The character of Kekaha, as it had been established in the Hawaiian consciousness, is represented in a traditional saying recorded by Mary Kawena Pukui and in a brief description by John Papa 'Ī'ī. The saying, "Kekaha wai 'ole na Kona", is defined by Pukui as "waterless Kekaha of the Kona district" and explicated by her as "Kekaha in Kona, Hawai'i, is known for its scarcity of water but is dearly loved by its inhabitants" (Pukui 1983:184). 'Ī'ī describes

> ...a cold wind from Kekaha, the Hoolua. Because of the calm of that land, people often slept outside of [sic] the tapa drying sites at night. It is said to be a land that grows cold with a dew-laden breeze, but perhaps not so cold as in Hilo when the Alahonua blows ['Ī'ī 1959:122].

These passages suggest that Kekaha was firmly identified with its austere physical environment. A legend told in Maguire (1966) reveals the importance of water resources in this general area (see also Wolforth et al. 2005:8-9). The story takes place at the Cave of Mākālei, which is located outside of the current project area near 'Akahipu'u (a nearby mountain). The story focuses on a man named Ko'amokumokuohe'eia, who moved to this area and was told by the current residents that water was very scarce. Water, he was told, could be obtained in "celebrated" caves, but these caves were *kapu* (forbidden), and if caught, trespassers would be killed by the owner of the cave. However, Ko'amokumokuohe'eia discovered a very small cave entrance that no else knew about. The cave had water dripping from its roof (Maguire 1966:30). Ko'amokumokuohe'eia and his father used carved *'ōhi'a* (*Metrosideros polymorpha*) and *wiliwili* (*Erythrina sandwicensis*) trees to capture the dripping water, and his family was thus able to survive during dry spells. This legend clearly demonstrates the importance of water as a difficult to procure resource, as well as highlighting the importance of water collection caves.

John Ka'elemakule Sr., a Kekaha native, wrote newspaper articles between 1928 and 1930 that provide details about life and customs in the last half of the 19th century. Kepa Maly (2003:41-42) translated these serial accounts that appeared in *Ka Hoku o Hawaii*. The two following excerpts provide additional details related to water collection:

> There were not many water holes, and the water that accumulated from rain dried up quickly. Also there would be weeks in which no rain fell... The water which the people who lived in the uplands of Kekaha drank, was found in caves. There

> are many caves from which the people of the uplands got water... [*Ka Hoku o Hawaii*, September 17, 1929:3].
>
> ...The *kūpuna* [elders] had very strict *kapu* (restrictions) on these water caves. A woman who had her menstrual cycle could not enter the caves. The ancient people kept this as a sacred *kapu* from past generations. If a woman did not know that her time was coming and she entered the water cave, the water would die, that is, it would dry up. The water would stop dripping. This was a sign that the *kapu* of Kāne-of-the-water-of-life (Kaneikawaiola) had been desecrated. Through this, we learn that the ancient people of Kekaha believed that Kāne was the one who made the water drip from within the earth, even the water that entered the sea from the caves. This is what the ancient people of Kekaha *wai 'ole* believed, and there were people who were *kia'i* (guardians) who watched over and cleaned the caves, the house of Kāne... [*Ka Hoku o Hawaii*, September 24, 1929:3].

Describing the apportioning of land by the *ali'i* (royalty) before the ascendancy of Kamehameha, the pioneer nineteenth-century Hawaiian historian Samuel M. Kamakau records this information about the lands of Kekaha:

> Waimea was given to the Pa'ao kahuna class in perpetuity and was held by them up to the time of Kamehameha III when titles had to be obtained. But there was one land title held by the kahuna class for many years and that was Puuepa in Kohala. In the same way the land of Kekaha was held by the kahuna class of Ka-uahi and Nahulu [Kamakau 1961:231].

Kamakau further records that during the 1770s, "Kekaha and the lands of that section" were held by descendants of the Nahulu line, Ka-me'e-ia-moku and Ka-manawa, the twin half brothers of the Hawai'i island chief Ke'e-au-moku (Kamakau 1961:310).

Kamakau mentions Kaloko in an episode that suggests that *ahupua'a's* significance within the pre-contact Kekaha landscape. Kamakau recounts an extraordinary day's reconnaissance of the west coast of Hawai'i Island by the spy Ka-uhi-o-ka-lani, sent to the island by Kama-lala-walu, chief of Maui. Having reached Kawaihae by canoe at night, Ka-uhi-o-ka-lani "ran about that same evening [reaching as far south as Ka'awaloa] and returned before the canoes were dismantled..." Ka-uhi-o-ka-lani, recounting his journey and the landmarks he had observed, relates: "I went on to the long stretch of sand, to the small bay with a point on that side and one on this side. There are large inland ponds." He is told that the "sandy stretch is 'Ohiki, and the walled-in ponds are Kaloko and Honokōhau" (Kamakau 1961:56). This event unfolds during the time of the sixteenth-century Hawai'i Island *ali'i* Lono-i-ka-makahiki, suggesting that by the 1500s Kaloko and its fishpond were well-known features in the Kekaha landscape.

Intensive archaeological investigation during recent decades has clarified the picture of pre-contact Hawaiian life within Kekaha and the *ahupua'a* under study. While exact population figures for Kaloko were not possible, it is suggested that the "community seems to have gradually grown in size but could never have been larger than 118 and most likely was about 60-100 in size" (Cordy et al. 1993:45). The general pattern of land use and settlement suggested for Kaloko may also have existed within the similar environment of neighboring *ahupua'a* as well.

It should be noted that the band of barren lava fields characterizing the Kekaha region does not encompass the entire *ahupua'a* nor does it inhibit land usage from occurring along the coast and inland where rainfall is sufficient for intensive agriculture. Instead, Kekaha refers more accurately to portions or "zones" of the regions where lava flows encompass the lands which, according to elevation, sustain little rainfall.

A detailed study of Kaloko by Cordy et al. (1991) for the National Parks Service has developed a model of pre-contact settlement throughout the *ahupua'a* of Kaloko. The following is a summary of this model provided by the National Parks Service (2001):

> Permanent settlements in the leeward portions of Hawai'i Island began by the A.D. 900s to 1000s, and possibly earlier. These would have occurred near favorable water sources, Kaloko bay probably having been one of the most sheltered and inviting large inlets along the Kona Coast. Coastal habitations had expanded by the 1200s, utilizing inland fields as well as sea resources for subsistence. The Kekaha lands north of Kaloko and extending to Kohala are thought to have undergone initial permanent settlement beginning in the 1400s, with subsequent occupation of the coast north and south over the next few centuries.
>
> Sometime during the period of 1580 to 1600, Laeanuikaumanamana, the *kahuna-nui* of the ruling chief, Liloa, acquired the Kekaha region. It is thought that the construction of fishponds at Kaloko and Honokahau began during this time, with Kaloko Fishpond dating from at least the 1400s to 1500s. During the 1600s to 1700s, as the Kona Coast population grew with the establishment of the royal residence of 'Umi-a-Liloa at Kona and the consequent increased demand for food production, Kaloko also increased to probably almost 200 residents. It continually supported a higher population than other Kekaha areas because of its fishpond and extensive inland field system [National Parks Service 2001].

Based on ethnographies, ethno-histories and archaeological sources, it has been suggested that the lands of Kekaha contain three general terrestrial zones that directly influenced land usage of prehistoric and historic populations. These three zones include: (1) Coastal; (2) Intermediate or Transitional and; (3) Upland. Previous archaeological studies in Kaloko Ahupua'a provide evidence for the activities that occurred in each of these zones.

The Coastal zone begins at sea level and extends to approximately 15 ft. a.m.s.l. This zone contains evidence of prehistoric and historic settlement in Kaloko. The Intermediate Zone extends from the *mauka* (upslope) margin of the coastal zone to approximately 400 ft. a.m.s.l. Throughout Kekaha, this zone is characterized by low rainfall and uneroded lava terrain. The Intermediate Zone of Kaloko contained a scattered distribution of habitations of different modes (i.e. temporary and recurrent) which were generally located within the vicinity of an extensive network of *mauka-makai* (seaward) trails or in association with other functional site types like agricultural an lithic resource procurement. The general lack of consistent rainfall and virtual absence of soil directly limits agricultural use within the Intermediate Zone. Nonetheless, small concentrations of mounds, modified outcrops (enclosing minimal soil areas), enclosures, and some *pāhoehoe* excavations evidence a degree of agricultural productivity. Lava tubes and

blisters are abundant in this zone and contain temporary components, and post-habitation burial interments.

The Upland Zone of Kaloko begins at approximately 400 ft. a.m.s.l. and continues *mauka*, including the present project area. The Upland Zone is characterized by an increase in permanent habitation sites in association with intensive non-irrigated (dry land) agricultural features. Gradually, the ascending natural landscape contains a greater soil base and due to an increase in elevation, the rainfall is more plentiful and consistent.

Intensive non-irrigated agriculture is characteristic of the Kona slopes and other regions of Hawai'i and Maui where irrigation, because of the lack of perennial waterways, is not possible. The "Kona Field System," generally defined by a grid-like patterning of stone constructed field boundaries, represents an interrelated network of intensive non-irrigated agriculture covering an estimated area of 139 km^2 (456,037 $ft.^2$) between Kealakekua Bay and Kailua Bay (Kirch 1985:225). Archaeological studies beyond the arbitrary northern boundary of the "Kona Field System" have documented evidence of intensive non-irrigated agriculture in the Kekaha region within the Upland Zone between 400 to 1200 ft. a.m.s.l. (i.e., Cordy 1985; Hammatt et al. 1987; Walker and Rosendahl 1990; Robins et al. 1993).

Intensive non-irrigated agriculture is characterized by concentrated occurrences of similar feature types (i.e. field walls, modified *'a'ā* [rough lava], *pāhoehoe* excavations, and mound complexes). Variations in the methods of non-irrigated agriculture occur as a response to topographical and geological variation, and rainfall in the region. Radiocarbon dates taken from upland field shelters within the Kona Field System indicates that intensive agriculture began developing between ca. A.D. 1400 - 1600 and intensified with permanent upland settlements between ca. A.D. 1600 - 1779 (Schilt 1984).

Into the last decades of the 18th century, following western contact, Kaloko—as an element of the larger Kekaha area—remained under the control of Ka-me'e-ia-moku, who resided to the north at Ka'ūpūlehu (Kamakau 1961:147).

3.1.2 Early Historic Period

By the first decades of the 19th century, the inhabitants of Kaloko would have long experienced the social pressures and consequences of western contact. "As early as 1788, Hawaiians began enlisting as seamen on the foreign ships that stopped at Island ports, and their number increased rapidly with the growth of whaling in the Pacific" (Schmitt 1973:16). As harbor facilities were developed at Kailua and Kealakekua during the early 1800s, these burgeoning ports became centers of a population drawn from increasingly isolated (economically and socially) areas like Kaloko. Newly-introduced diseases cut the population severely.

Kaloko is recorded by Kamakau as the site where Kamehameha's bones were cached after his death in 1819:

> Kamehameha had...entrusted his bones to Ulu-maheihei Hoa-pili with instructions to put them in a place which would never be pointed out to anyone. At midnight, therefore, when black darkness had fallen and no one was likely to be on the road and the rough lava plains of Pu'ukaloa lay hushed, Hoa-pili sent his man, Ho'olulu, to bring the container of wicker work in which the bones of

> Kamehameha were kept to Kaloko in Kekaha...The next morning Hoa-pili and Ke-opu-lani took canoe to Kaloko where Hoa-pili met the man who had charge of the secret cave and together they placed the bones there [Kamakau 1961:215].

Kamakau's account, if accurate, suggests that Kaloko's population, toward the end of the 19th century's second decade, had diminished to such an extent that the *ahupua'a* could provide the necessary isolation and secrecy for the burial.

Missionary censuses of the 1830s chart the diminishing population of Kekaha and North Kona. In 1834, the total population of Kekaha is recorded as 1,244, comprising 21% of the total North Kona population of 5,957 (Schmitt 1973:31). The North Kona figure represents a population loss of 692 since the previous census of 1831 (during which no figure specific to Kekaha was noted), which recorded 6,649 persons in the district (Schmitt 1973:9). One factor inducing the diminishing population of Kona, inter-island migration, was specifically noted by missionaries in 1832: "We have been sensible for some time that the number of inhabitants in this island is on the decrease. There is an almost constant moving of the people to the leeward islands, especially since the removal of the governor (Kuakini) to Oahu. Some leave by order of the chiefs, and others go on their own responsibility" (cited in Schmitt 1973:16).

3.1.3 The Māhele

In 1845, the Board of Commissioners to Quiet Land Titles, also called the Land Commission, was established "for the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property" (Chinen 1958:8). This led to the Māhele of 1848, the division of lands between the King of Hawai'i, the *ali'i*, and the *maka'āinana* (common people), which introduced the concept of private property into the Hawaiian society. Previous to the Māhele, all land belonged to the *akua* (gods), held in trust for them by the paramount chief, and managed by subordinate chiefs.

Under the Māhele, Kamehameha III divided the land into four divisions: certain lands to be reserved for himself and the royal house were known as Crown Lands; lands set aside to generate revenue for the government were known as Government Lands; lands claimed by *ali'i* and their *konohiki* (supervisors) were called Konohiki Lands; and habitation and agricultural plots claimed by the common people were called *kuleana* (Chinen 1958:8-15). 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. In theory, this "setting aside" of hundreds of thousands of acres as potential *kuleana* parcels ultimately led to about 10,000 claimants obtaining approximately 30,000 acres, while 252 chiefs, for example, divided up about a million acres. Many or most Hawaiians were simply disenfranchised by these acts.

Records generated during the 1840s for Land Commission Awards (LCAs) conferred at mid-century document the disposition of population and land use within Kaloko Ahupua'a that had evolved since western contact. At the Māhele of 1848, Kaloko was claimed by and awarded (LCA 7715) to Lot Kamehameha (who would become Kamehameha V). Subsequently, 18 *kuleana* claims, by commoners claiming to occupy and/or cultivate land parcels, were made in Kaloko. Twelve of these claims were awarded. All claims were for *mauka* lands, between 1200 and 1700 ft. elevation, adjacent to or just *makai* of the Government Road and *mauka* of the current project area. Only testimony for Kahiona's LCA 9205/9237 claim (which was not

awarded) mentions a fishpond; no site within the coastal area is claimed. Farmlands claimed are *māla*, *kīhāpai*, and *mo'o*, i.e. forms of dry land agriculture; actual crops identified in the award testimonies are taro and sweet potato. Only five of the total 18 claims mention residence on or use of the Kaloko lands dating to the time of Kamehameha I, the first decades of the nineteenth century; the remaining claims testify to residence/use beginning in the 1830s and 1840s.

Beginning in the 1850s, the first taxpayer rolls for Kaloko were documented. They indicate that within Kaloko 19, 21 and 23 taxpayers were recorded during the years 1857, 1859 and 1860, respectively. Just past the middle of the 19th century, the population of Kaloko had been drawn beyond the original subsistence-based economy into the western commercial paradigm.

Coulter's (1931) population density estimates for 1853 (Figure 6) show that a few hundred people lived in the general vicinity of the present project area during the mid 1800's. Cordy notes about Kaloko: "The historical documents suggest that by the 1840s-1850s, the Coastal Zone had been abandoned as a residential area, except probably for a house used by the fishpond's caretaker. This pattern would have been a stunning change from prehistoric and early historic times, when many coastal residences were present," (Cordy 1981:288). It is likely that the present project area was never a location of dense permanent settlement.

Oral history interviews (Maly and Maly 2003) also relate that in the mid 1800s only a few residences were on the coastal lands, in the uplands above 900 ft. elevation, and in the vicinity of Māmalahoa Highway (*mauka* of the project area). The land between 900 ft. and the coast was cattle, donkey, and goat pasturage. *Mauka-makai* trails through *ahupua'a* including Kaloko were utilized by upland families to access the coast to fish, and gather water during upland droughts.

3.1.4 Mid-to-Late 1800s

Kaloko is documented during the 1870s in testimonies by Hawaiians before the government's Boundary Commission. Testifying on August 12, 1873, Nahuina (who had earlier received LCA 10327 in Kaloko) describes himself as "born at Kaloko North Kona Hawaii at the time of Keikepuipui, the building of the *heiau* at Kailua, and have always lived there" and states that the boundaries of Kaloko were shown to him by his father, the former *konohiki* of the *ahupua'a*. Identifying the *mauka* portions of the boundary, Nahuina notes bounds defined by vegetation and a wall (*iwi aina*), and recalls a former habitation site:

> ...From the *makai* side of Kaupulehu the boundary runs along said land, the *koa* being on Kaloko and the *mamani* and *pukeawe* [sic] on Kaupulehu to the corner of Lanihau 2nd Keahuolu and Honokohaunui...Ohiawela, a *pali*, on the road through the woods is a point on the boundary. This place is above Honokohaunui, thence turn *makai* to Kahua, a place in the fern where houses used to stand, from thence the boundary runs *makai* along an *iwi aina* to Kapokalani, at the Government road. Thence *makai* still following the *iwi aina* to Kiikii an *ili aina*, thence to Kaohe, a grove of trees thence to *aa*...

Nahuina adds that Kaloko has "ancient fishing rights extending out to sea." Testifying on the same date, Hoohia, who "moved to Honokohauiki when quite small and reside[s] there now", adds details that suggest the *mauka* Kaloko-Honokohau boundary was defined by different vegetation that also reflected former traditional gathering rights: "Honokohaunui ends at

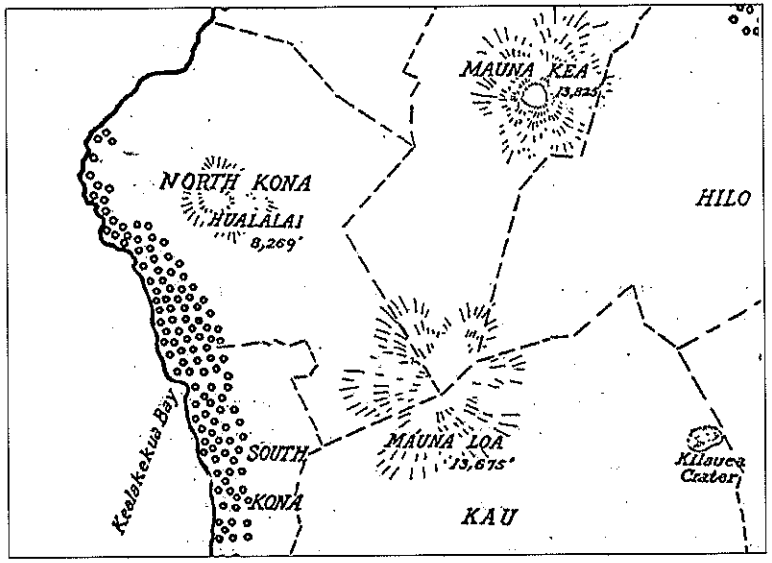

Figure 6. Population estimates for Hawai'i Island in 1853 by Coulter (1931); each symbol represents 50 people, indicating several hundred people settled in North Kona

Ohiawela, a *pali* [cliff]. Kaloko takes the *koa* [*Acacia koa*], and Honokohaunui, the *ohia*...The *olona* [*Touchardia latifolia*] grows on Honokohaunui and Kealakehe and the *koa* on Kaloko."

During the 1880s, Kona lands including Kaloko were surveyed by J.S. Emerson for the Hawaiian government. A portion of his Registered Map (RM) 1449 shows a trail north of the project area; the trail actually ran from the Kohanaiki Homesteads to the Kaloko fishpond and was known as the "Road to the Sea". A composite of RM 1449 and RM 1512 (Figure 7) provides a view of both the country side and the detail in the area of the Kohanaiki Homesteads. Most visible are family claims in the Kohanaiki Homesteads and the Road to the Sea running directly *makai* from the homesteads. The Kaloko Catholic church is shown in the vicinity of the modern Kona Heavens subdivision, while a house belong to a G. Clark is also depicted, east of the project area (see Figure 7).

In addition to RM 1449 and RM 1512, Emerson also produced RM 1280 (Figure 8) during this time period. Concurrently, Emerson's assistant, J. Perryman, produced sketches of the west slopes of Hualālai. Though other surveyors and historians have produced maps for the area, these

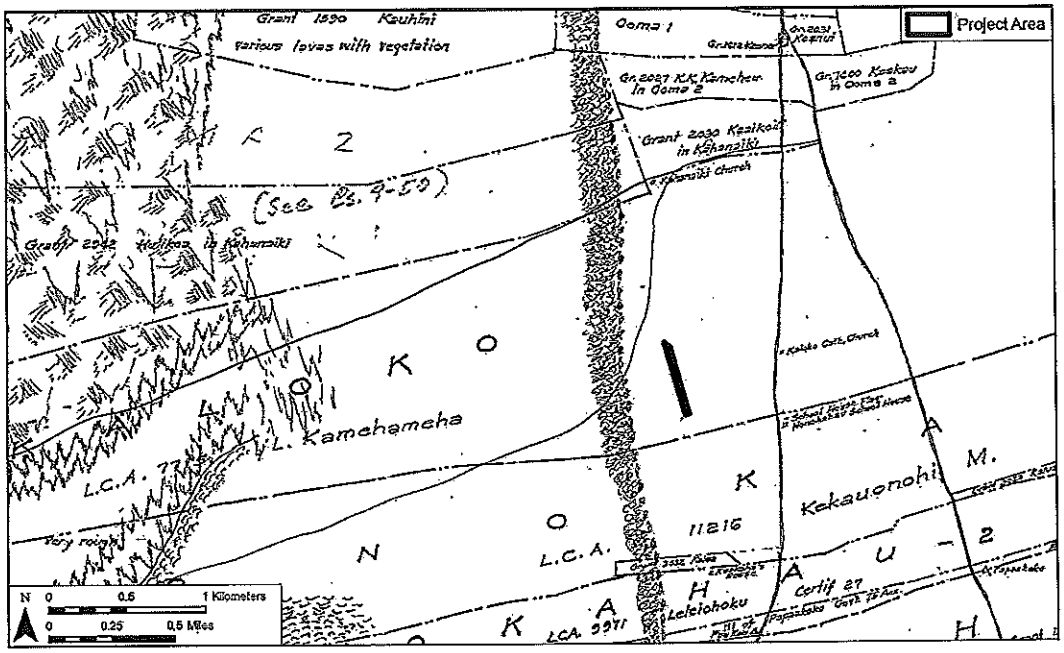

Figure 8. Portion of Registered Map 1280 by J. S. Emerson showing the approximate location of the project area in relation to features discussed in the text

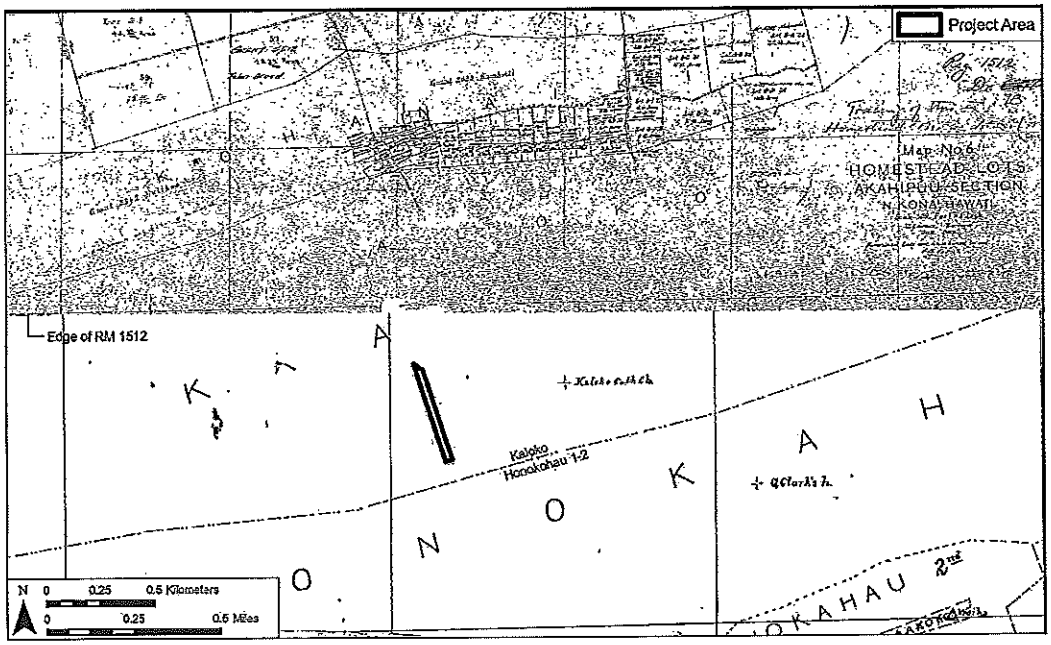

Figure 7. Portions of Emerson's RM 1449 (1888) and RM 1512 (1889) showing the approximate location of the project area in relation to the Kohanaiki Homesteads and its "Road to the Sea"

maps are the most comprehensive known. RM 1280 is perhaps cited and reproduced with the most frequency. It is often dated to 1888, but in fact the map does not indicate the date, only the date the map was traced by another surveyor in 1952 for reproduction purposes. An independent attempt to verify its date during a past CSH study was unsuccessful, as the original map is now retired and not available from the State Survey office. Circumstantial evidence dating the map includes the sketches of J. Perryman dated to 1882, which match the features of this map well and a date range penciled on the back of the traced map on file: "1877-1903." RM 1449 and RM 1512, dating to 1888 and 1889 respectively, are essentially maps of the same series. RM 1449 is a broad overview map ranging from Kaloko to Kūki'o in the north, RM 1512 is a detail of the land grants around the government road.

Like RM 1449, RM 1280 shows the location of the "Kaloko Cath. Church" and a road passing the current project area to the north, presumably corresponding to the Road to the Sea shown on RM 1449 and RM 1512 (see Figure 8). Emerson's RM 1280 also indicates the land grants in the vicinity of the Kohanaiki Homesteads, a house belonging to a Kuakaha south of the project area, and the Honokohau school house and flag about a quarter mile southeast (see Figure 8). Cordy (1991:418) suggests a "late 1880s age for the formation of the Kohanaiki Homesteads". Kelly (1971) notes that the Kohanaiki Homesteads would have drawn people as other areas of North Kona were abandoned. Government records of Kohanaiki grants show 18 parcels ranging in size from 0.73 acres to 25.45 acres awarded between 1895 and 1904.

Kaloko continued to be held by the *ali'i* throughout the remainder of the 19th century, passing, after the death of Lot Kamehameha, successively to Bernice Pauahi Bishop, Kalākaua and Kapi'olani.

3.1.5 1900s

During the 20th century, major developments occurred within Kaloko Ahupua'a, with continuing commercial use of the fishpond and increasing animal husbandry. The neighboring Kohanaiki Homesteads were apparently in decline during the early part of the century (Maly and Maly 2003), and are mentioned only in passing in H.W. Kinney's 1913 visitor's guide, which notes that it is an "inland settlement without much interest".

Ranching, however, steadily increased. Once John Maguire purchased the former chiefly lands of Kaloko in 1906 after the deaths of Kalakaua and Kapiolani (Kelly 1971:29), the *ahupua'a* uplands were developed into the Huehue Ranch. Maly and Maly (2003) discuss the acquisition of these lands and the types of ranching that were common:

> In 1899, John A. Maguire, founder of Huehue Ranch applied for a Patent Grant on... lots in 'O'oma 2nd, but he only secured Grant No. 4536.... Maguire's Huehue Ranch did secure General Lease No.'s 1001 and 590 for grazing purposes on the remaining government lands in the Kohanaiki and 'O'oma vicinity. Thus, by the turn of the century, Huehue Ranch utilized both the upper forest lands and lower kula lands to the shore for ranching purposes. Oral history interviews with elder former ranch hands record that this use extended across the Kapena and Huliko'a grant lands of Kohanaiki, from the fee and leasehold lands of Kaloko and 'O'oma. Nineteenth century goat drives, gave way to formalized cattle drives and round ups on these lands [Maly and Maly 2003:78].

Until the construction of the Queen Ka'ahumanu Highway in the 1970s, access to the "*kula kai* (shoreward plains)" (Maly and Maly 2003:101) was limited to local residents. The 1924 USGS map depicts the Road to the Sea connecting the Kohanaiki Homesteads with the Kaloko fishpond (visible as a dashed line on Figure 9), passing north of the current project area at the *ahupua'a* boundary between Kohanaiki and Kaloko. The Kohanaiki Homesteads were located less than one mile northeast of the project area (see Figure 7 through Figure 9). In the first half of the 20th century, the primary method of travel was "by foot or on horse or donkey, and those who traveled the land, were almost always native residents of Kalaoa, 'O'oma, Kohanaiki, Kaloko and Honokōhau" (Maly and Maly 2003:99). Huehue Ranch bulldozed a jeep road to the shore around 1955 during the construction of the Kailua pier, and this was used primarily by the ranch employees for duties or for going fishing along the coast. The Huehue Ranch jeep road and other signs of animal husbandry activity can be seen on the 1959 U.S. Geological Survey map (Figure 10). Portions of this jeep road still exist within Kaloko today.

During the 1940s and 50s the portion of Kaloko within and surrounding the current project area was cleared for pasturage (Barrera Jr. 1985:6). These impacts are discussed in further detail in Section 3.2.2. The abandonment of these pastures allowed invasive vegetation to proliferate, resulting in the dense non-native forest present in the project area today.

The Kaloko fishpond, leased from the Huehue Ranch, continued as a commercial fishing operation until the 1950s. During the 1970s, the pond was incorporated into the newly-established Kaloko-Honokōhau National Historic Park.

3.1.6 Modern Land Use

While the present project area is undeveloped, surrounding areas have seen increasing modern use. A 1978 U.S. Geological Survey Orthophoto of the area (Figure 11) shows the Huehue Ranch jeep trail mentioned above, and the beginnings of the Kona Heavens housing subdivision. Figure 11 also shows a light-shaded area adjacent to the Kona Heavens subdivision covering portions of the project area; this may represent a staging area or some other disturbance related to construction of the subdivision. In contrast to the modern aerial photo (see Figure 3), Figure 11 does not depict Hina Lani Street extending *makai* beyond the Kona Heavens development and past the project area. Hina Lani Street now marks the northern boundary of the project area and leads *makai* to the modern Kaloko Industrial Area and Queen Ka'ahumanu Highway. The Kaloko Industrial Area includes large stores such as Home Depot and Costco. Large water tanks are situated along Hina Lani Street, and new housing subdivisions are being planned and constructed here as well, including the new Kaloko Housing Project and the proposed Kaloko Heights subdivision (not shown on Figure 3).

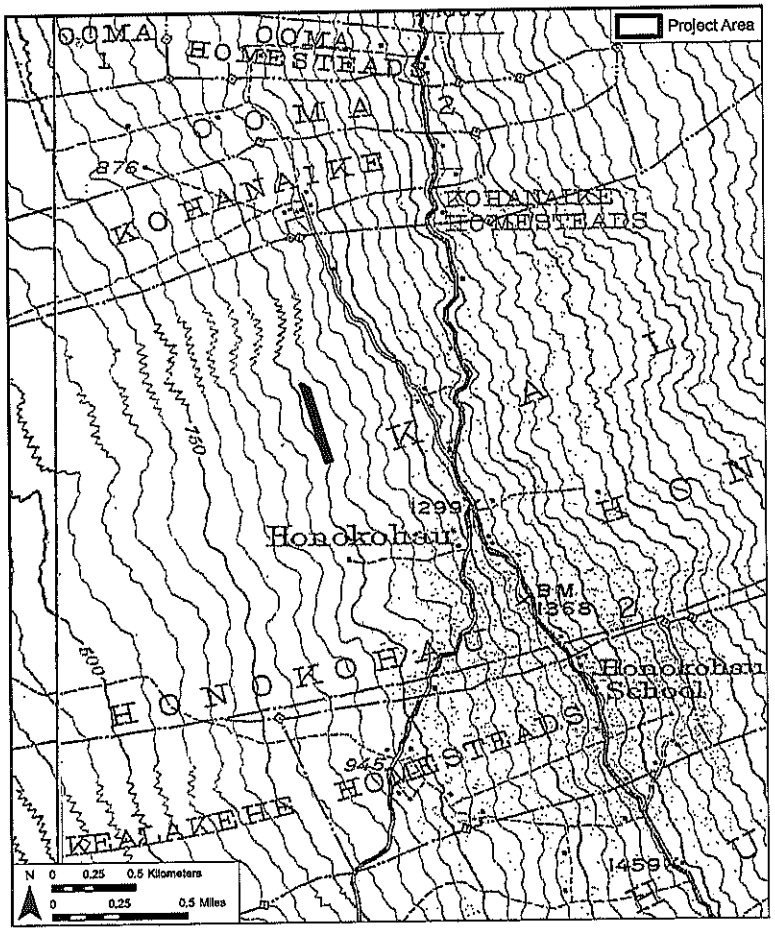

Figure 9. Portion of 1924 U.S. Geological Survey topographic map, Kailua quadrangle, showing the approximate location of the project area in relation to features discussed in the text

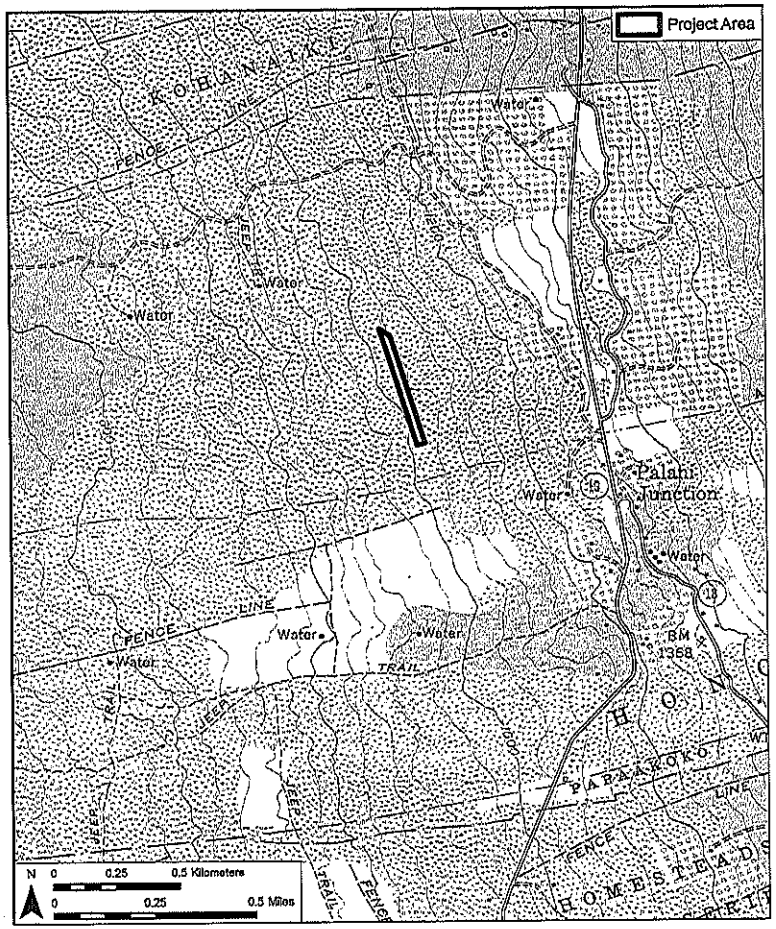

Figure 10. Portion of 1959 U.S. Geological Survey map, Kailua quadrangle, showing the approximate location of the project area in relation to features discussed in the text

Figure 11. Portion of 1978 U.S. Geological Survey Orthophoto, Kailua quadrangle, showing the location of the project area in relation features discussed in the text; note the historic jeep trail meandering across the top register of the photo

3.2 Previous Archaeological Research

3.2.1 Overview of Archaeological Studies Conducted within Kaloko Ahupua'a

This section provides a general overview of past archaeological studies in Kaloko Ahupua'a. These studies are shown on Figure 12 and listed chronologically in Table 1 with brief comments; they are discussed in additional detail in the text. Section 3.2.2 discusses the previous archaeological study that overlaps the present project area (Barrera Jr. 1985) in greater detail. Generally speaking, most work in Kaloko has been concentrated at the coast and along the Queen Ka'ahumanu Highway and Hina Lani corridors *makai* of the project area.

Previous archaeological surveys conducted within portions of Kaloko (and neighboring Kohanaiki) Ahupua'a began with the early coastal survey conducted by John Reinecke for the Bernice P. Bishop Museum in 1929-1930 (Reinecke 1930). This was a cursory survey in which approximate site locations and very brief site descriptions were recorded. John Reinecke (1930) recorded eight sites at the coast of Kohanaiki; the sites, minimally documented and mapped, included habitation sites and a *heiau*. No sites were recorded in Kaloko. The next survey was undertaken by Kenneth Emory and Lloyd Soehren in 1971 (Emory and Soehren 1971). This was also a coastal survey, and focused specifically upon the coast of Kaloko, Honokōhau, and Kealakehe. In 1970 and 1971, Robert Renger and students from the University of California at Santa Barbara conducted an intensive survey of Kaloko and Honokōhau between present day Queen Ka'ahumanu Highway and the coast (Cordy et al. 1991). This survey also included subsurface testing of selected sites. These three surveys identified a total of 94 sites within Kaloko between the coast and Queen Ka'ahumanu Highway as of 1971.

Additional archaeological work and historical research undertaken within or about Kaloko during the 1970s and 1980s include: an historical study by Marion Kelly (Kelly 1971); research relating to the establishment of the Kaloko-Honokōhau National Park (e.g. Honokōhau Study Advisory Commission 1974, National Park Service 1975); research stemming from the fieldwork conducted by Renger in 1970-71 (see the list presented in Cordy et al. 1991:2); and several reconnaissance-level studies (Ching 1980, Hammatt 1980, Soehren 1983).

During an inventory survey in 1986 that largely fell in Kohanaiki Ahupua'a to the north (Donham 1986), PHRI reported that "14 previously recorded sites were relocated and 91 sites were newly identified...Habitation sites represented over half of the identified site total, and included habitation complexes, habitation/ceremonial and/or habitation/burial complexes, and temporary habitation sites" (Donham 1986:7-8). In 1991, PHRI performed data recovery of the 1986 project area (O'Hare and Goodfellow 1992); this work included: "detailed recording of (a) 31 sites (224 features) previously recorded in the project area, and (b) seven sites newly recorded during the Phase II work" (O'Hare and Goodfellow 1992:ii). Summarizing Kohanaiki settlement pattern within the zones represented by the project area, the report notes:

Table 1. Previous Archaeological Studies Within Kaloko Ahupua'a (project overlapping current project area is in bold)

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Reinecke 1930	Cursory survey	Coastal Survey	Briefly notes numerous sites	*Makai* of present project area
Emory & Soehren 1971	Cursory survey	Coastal Survey	Briefly notes numerous sites	*Makai* of present project area
Kelly 1971	Historical survey and background	Kaloko and Kuki'o *ahupua'a*	Background study	Good background study; *makai* of present project area
Renger 1971	"Field Notes" of "*Mauka* excavations"	"*Mauka* excavations"	"Field Notes" describe several sites	No site location map thus hard to be sure where sites are; *makai* of present project area
Soehren 1979	Letter Report Reconnaissance Survey	Kaloko Access Road Corridor (Hina-Lani Street)	No finds	Letter Report not actually seen.
Soehren 1980a	Letter Report Reconnaissance Survey	Kaloko lowlands	No finds	Letter Report not actually seen.
Soehren 1980b	Letter Report Reconnaissance Survey	Kaloko Access Road Corridor	Discusses 3 stepping stone trails, 2 *ahu* & a lava tube complex	Hina Lani Street. Letter Report not actually seen
Ching 1980	Letter to Mr. Clifford H.F. Lum regarding an archaeological reconnaissance survey	TMK 7-3-09	-	Letter Report not actually seen

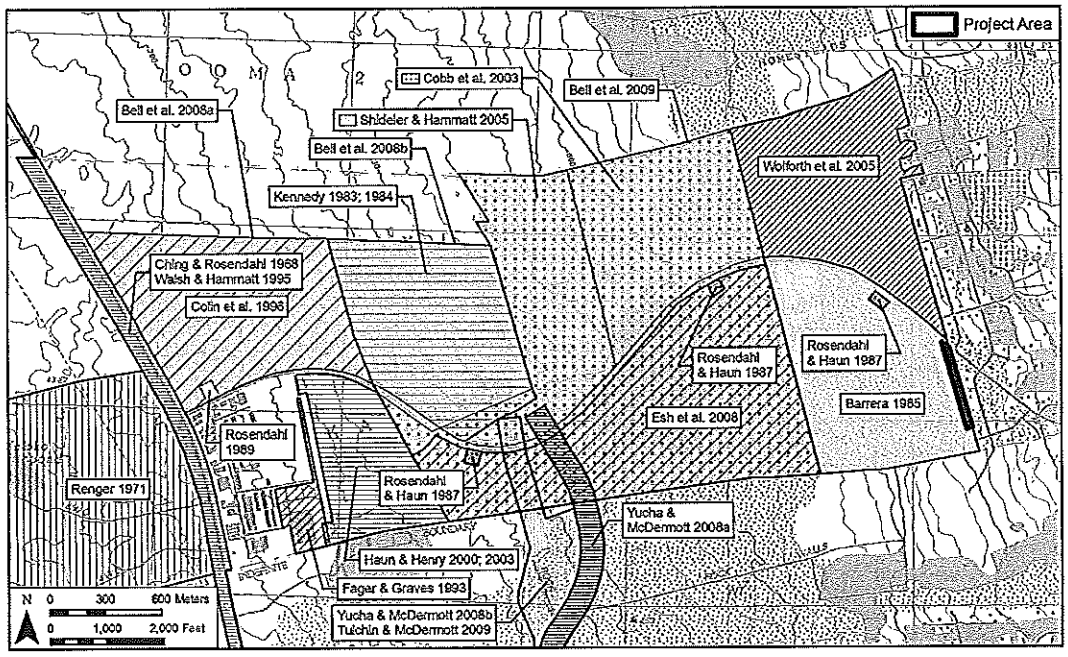

Figure 12. Portion of the 1996 U.S. Geological Survey 7.5' topographic map, Kailua Quadrangle, showing the locations of the current project area in relation to previous archaeological studies in Kaloko Ahupua'a

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Rosendahl 1989a	Letter Report Addendum to Archaeological Inventory Survey	Addl info re: site 13493 stepping stone trail by *makai* tank	Identified one *pāhoehoe* slab trail (site 13493)	Water tank along Hina Lani *makai* of present project site
Rosendahl 1989b	Field Inspection	Kaloko Mauka Parcel # 1	Identified 4 sites	Report not actually seen
Rosendahl 1989c	Field Inspection	Kaloko Mauka Parcel # 2	No sites identified	Report not actually seen
Rosendahl & Walker 1990	Addendum to Archaeological Inventory Survey	Addl info re: site 13493 trail by *makai* tank	Addl info re: site 13493 trail by *makai* tank	Water tank *makai* of present project site along Hina Lani
Rosendahl & Walker 1991	Archaeological Field Inspection	Industrial crusher site, 2 adjacent 10 acre parcels	Identified a trail with two cairns	South of present project site
Barrera Jr. 1991	Archaeological Inventory Survey & Data Recovery Report	800 to 1100'	Identified 61 sites	North of present project area across Hina Lani Street; same project area as Wolforth et al. 2005
Cordy et al 1991	An Ahupua'a Study: The 1971 Archaeological Work at Kaloko	Kaloko-Honokōhau National Park	94 sites identified	*Makai* of present project area
Kennedy 1991	Surface Reconnaissance	Long thin industrial development	No significant finds	*Makai* of present project area

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Hammatt (ARCH) 1980	Archaeological Reconnaissance TMK: 7-3-09, Portions of Parcels 1 and 17	420 acre parcel	Identified 2 sites	Report not actually seen; project was located *makai* of present project area in upland Kaloko and Kohanaiki
Barrera Jr. 1983	Archaeological Reconnaissance	TMK 7-3-9:19	No finds	No map
Soehren 1983	Archaeological Reconnaissance Letter Report	-	-	Not seen
Kennedy 1983	Archaeological Reconnaissance	Within present project site	Identifies 27 sites	*Makai* of present project area
Kennedy 1984	Intensive Archaeological Survey	Within present project site	Results of investigations of 25 sites	*Makai* of present project area
Barrera Jr. 1985	**Archaeological Survey**	**409 acres 700 to 1080' elevation**	**58 sites**	**Overlaps present project area**
Donham 1986	Archaeological Reconnaissance Survey	470-acres *makai* of Queen K Hwy	105 sites	*Makai* of present project area
Rosendahl & Haun 1987	Archaeological Reconnaissance Survey	3 1-acre parcels	Their project area *mauka* of present project area had one site	Water tanks along Hina Lani Street. *Makai* of present project area
Barrera Jr. 1988	Archaeological Excavations	YO Project Area	60 sites	North of present project area across Hina Lani Street

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Rechtman 1998	Archaeological Field Inspection	2400-2500' elevation	No finds	*Mauka* of present project area
Rechtman & Henry 1999	Archaeological Inventory Survey	1450-1620' elevation	Identified 15 sites	*Mauka* of present project area
Wolforth 1999	Monitoring Report	HELCO Keähole-Kailua Transmission line corridor	Describes one site 21258	*Makai* of present project area
Haun & Henry 2000	Archaeological Inventory Survey	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre parcel	45 sites with 81 features	*Makai* of present project area, south of Hina Lani Street
Rosendahl 2000	Archaeological Assessment	2435-2730' elevation	No finds	*Mauka* of present project area
Clark & Rechtman 2002	Archaeological Inventory Survey	1200' to 1600' elevation	Identified 5 sites	*Mauka* of present project area
Haun & Henry 2002	Data Recovery Plan	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre	Data Recovery Plan addresses 8 specific sites	*Makai* of present project site south of Hina Lani Street
Rechtman & Rivera 2002	Archaeological Assessment	3-7-3-26:4; 3,1000'	No finds	*Mauka* of present project site

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
O'Hare and Goodfellow 1992	Data Recovery	TKM:3-7-3-09:3; Donham 1986 project area	Detailed recording of 31 sites (224 features) previously recorded in the project area, and of seven sites newly recorded	*Makai* of present project site
Barrera Jr. 1993	Archaeological Inventory Survey	5.7 acres; 1450 to 1630' elevation	Identified 40 features of Kona Field System	*Mauka* of present project area
Fager & Graves 1993	Archaeological Inventory Survey	Kaloko Industrial Park parcel	Identified 17 sites with 60 component features	*Makai* of present project area, south of Hina Lani Street
Fager & Rosendahl 1993	Interim Report Archaeological Inventory Survey	Kaloko Industrial Park parcel; 15+ acres	Identified 17 sites with 60 component features	*Makai* of present project area, south of Hina Lani Street
Henry & Graves 1993	Archaeological Inventory Survey	Transmission line project *mauka* side of Queen K Hwy.	Identified 8 sites *makai* of project area	*Makai* of present project area
O'Hare & Rosendahl 1993	Report on burials	On coast	Report on burials	Kohana-iki Resort project, *makai* of present project area
Rosendahl 1993	Archaeological Field Inspection	Kaloko Mauka Parcel	4 sites discussed	Report not actually seen
Nees & Williams 1995	Archaeological Investigations, (TMK: 3-7-3-24: 010,3-7-3-25: 016)	110 acres, 2100 to 2900' elevation	Identified enclosure, lava tube, terrace, wall, mounds	*Mauka* of present project site
Walsh & Hammatt 1995	Archaeological Inventory Survey	Queen K Hwy Right-of-Way	Identified 9 sites adjacent to *makai* side of Hwy in Kohanaiki & Kaloko	*Makai* of present project area
Colin et al. 1996	Archaeological Inventory Survey	224 acres *makai* of present project area	Identified 55 sites	*Makai* of present project area

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Haun and Henry 2005	Archaeological Inventory Survey	Proposed Reservoir along Hina Lani Street at TMK: 7-3-009:49. Corresponds to Rosendahl 1989 *mauka* study area	The wall identified by Rosendahl and Haun (1987) was relocated, assigned as site 24329, and recommended for no further work	Just *makai* of present project area
Shideler and Hammatt 2005	Archaeological Field Inspection and Literature Review	1,200+ Acres in Kaloko and Kohanaiki	Numerous pre-contact sites observed, including: habitations, agricultural features, petroglyphys, boundary walls, and burials	*Makai* of present project area
Wolforth et al. 2005	Archaeological Inventory Survey	TMK: [3] 7-3-09: 032	A total of 89 sites were identified, consisting of burials, perm. habitation, temp. habitations, religious sites, trails, boundary walls, and agricultural sites	North of present project area across Hina Lani Street; same project area as Barrera Jr. 1991
Bell et al. 2008a	Archaeological Inventory Survey	224+ acres at TMK: [3] 7-3-09: 017. Same project area as Colin et al. 1996	A total of 59 historic properties were identified within the project area; 53 were previously identified and six were newly recorded, and were of pre-contact traditional Hawaiian origin Cairns, simple agricultural features, recurrent and temporary habitation sites, trails, enclosures, walls, and a quarry were documented	*Makai* of present project area

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Cobb et al. 2003	Archaeological Assessment	TMK: 7-3-09:25, 26 & 28 at Kaloko and Kohanaiki (400 acres)	Briefly identifies 154 features	Descriptions quite brief; map hard to correlate with sites found in present survey. *Makai* of present project area
Haun 2003	Archaeological Assessment	400-Acre Portion of TMK 7-3-09:28 Kaloko	Identifies 8 sites (63 features) in present project area	Helicopter flight overhead led him to focus on open *'a'ā* area. South of Hina Lani Street, *makai* of present project area
Haun et al. 2003	Data Recovery Report	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre	Data Recovery Report addresses 8 specific sites	*Makai* of present project area, south of Hina Lani Street
Moore & Kennedy 2003	Archaeological Inventory Survey	Roadway Corridor, TMK 7-3-09:28 (por)	Identified 1 site (23973) 2 mounds	*Makai* of present project area
Puette & Dye 2003	Archaeological Inventory Survey	22 acres 2100 to 2400' elevation	No finds	*Mauka* of present project area
Rechtman 2003	Archaeological Assessment	3-7-3-26:5; 3,1000' elevation	No finds	*Mauka* of present project area
Elmore et al. 2004	Archaeological Inventory Survey	1400' elevation	Identified one historic site 24133	*Mauka* of present project area

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Yucha and McDermott 2008b	Archaeological Inventory Survey	TMK: [3] 7-3-009: 025, 028, 999 (por.) and 7-4-008: 005 and 047 (por.)	33 historic properties were identified, comprising 179 features. Twenty of the sites were identified during previous AIS investigations (Esh et al. 2008; Robins et al. 2000). All but three of the sites were considered to be pre-contact. Site types included mounds, modified outcrops, pavements, enclosures, platforms, terraces, lava blisters, lava tubes, modified depressions, alignments, cleared areas, walls, cairns, trails, petroglyphs/ pecking, a *papamū* [stone on which the checker-like game, *kōnane*, was played], a rockshelter, and a cattle trough	*Makai* of present project area
Bell et al. 2009	Archaeological Inventory Survey	194+ acres at TMK: [3] 7-3-09: 026	120 sites documented, of which 114 were newly recorded. Site ages and types similar to those discussed for Esh et al. 2008 above	*Makai* of present project area
Tulchin and McDermott 2009	Addendum Archaeological Inventory Survey	TMK: [3] 7-3-009: 025, 028, 999 (por.) and 7-4-008: 005 and 047 (por.)	Revisited a previously-recorded historic cattle wall (SIHP #50-10-27/28-18115) located within the project APE that not included in the aforementioned inventory survey report (Yucha & McDermott 2008)	*Makai* of present project area

Source	Nature of Study	Area of Study	Finds (all site nos. prefixed by 50-10-27 or 28-)	Comments
Bell et al. 2008b	Archaeological Inventory Survey	360+ acres at TMK: [3] 7-3-09: 025. Includes lands previously surveyed by Kennedy 1983, 1984 and Cobb et al. 2003.	121 historic properties documented, of which only two were known with certainty to be previously recorded. Most sites were of pre-contact traditional Hawaiian origin, though some were historic. Site types included complexes, walls, trails, lava tubes, mounds, enclosures, platforms and modified outcrops. Burials present	*Makai* of present project area
Esh et al. 2008	Archaeological Inventory Survey	363+ acres at TMK: [3] 7-3-09: 028	41 sites were documented, all newly recorded. Most sites were of pre-contact traditional Hawaiian origin, though some were historic. The types of sites observed in these project areas included complexes, walls, trails, lava tubes, mounds, enclosures, platforms and modified outcrops. Burials present	Along the south side of Hina Lani Street, *makai* of present project area
Yucha and McDermott 2008a	Literature Review and Field Inspection	Kaloko and Honokohau Ahupua'a. TMK: portions of [3]-7-3-09:025, 028	Numerous pre-contact sites observed.	Portion of the Ane Keohokālole Highway (Henry Street Extension), *makai* of present project area

> The data recovery work indicates that permanent habitation sites between Puhili and Wawahiwaa Points are concentrated in the coastal zone, near the shoreline. In the coastal area south of Wawahiwaa Point permanent habitation sites were near the shoreline and further inland. Temporary habitation sites were present in all areas of the coastal zone and in the barren rockland zones. The radiocarbon date ranges indicate that sites in the northern coastal zone might have been inhabited as early as AD 1020. Sites in the southern coastal zone may have been inhabited as early as AD 1370, and sites in the barren rockland zones may have been inhabited as early as AD 1180. In the barren rockland zones, use of the sites was terminated before the historic period, and in the coastal zone most of the sites were not used in the historic period [O'Hare and Goodfellow 1992:ii].

Given the proximity of Kohanaiki, a similar settlement pattern can be inferred for Kaloko.

In 1983 Joseph Kennedy conducted a reconnaissance and subsequent intensive survey (1984; see Figure 12) of a parcel overlapping Kohanaiki and Kaloko. The 1983 reconnaissance located and briefly described twenty-seven sites. These sites included 17 lava tubes, three cairns, two walls, two platforms, an enclosure, a modified outcrop, and a trail. The 1984 intensive survey identified:

> 45 separate cave openings and approximately 200 chambers in these caves. In addition there were 4 walls recorded, 5 enclosures, 13 platforms, 9 cairn, 2 trails and 2 sets of petroglyphs. Out of the 79 separate features on the property, 30 were judged to be worthy of re-investigation ... the remaining 49 sites that were not reinvestigated were comprised almost exclusively of relatively shallow caves with little or no evidence of cultural remains or associated modifications [Kennedy 1984:18].

Many (but not all) of the sites identified in 1984 are described and some of these sites were mapped. Excavations were carried out in three caves (Sites 11, 22 and 49 in the Kennedy 1984 numbering system.

In 1987, Paul H. Rosendahl Inc. accomplished an archaeological reconnaissance survey of three one-acre parcels for proposed water tank sites in Kaloko (TMK: 7-3-09:Por.1,17) (Rosendahl and Haun 1987; see Figure 12), along the south side of the then "main access road between Queen Ka'ahumanu Highway and Kona Heavens Subdivision" (i.e. the present Hina Lani Street). The parcels were located at 350 ft. above mean sea level (A.M.S.L.), 630 ft. A.M.S.L., and 910 ft. A.M.S.L. Only one site (site 50-10-28-10887), an historic wall interpreted as a boundary or cattle wall, was recorded within the *mauka*-most parcel. Subsequently, in 1989, an additional water tank site parcel (TMK: 3-7-3-10:Por.17), measuring 360 ft. north/south and east/west, was subject of an archaeological inventory survey (Rosendahl 1989). The parcel bordered the north side of the then "proposed Kamanu Street extension in the Kaloko Light Industrial Park" at the south boundary along Hina Lani Street. A steppingstone trail segment measuring was recorded and designated state site 50-10-27-13493.

In 2005, Haun and Henry returned to the *mauka*-most parcel (at 910 ft amsl) to conduct an AIS for a proposed reservoir (not shown on Figure 12). The wall identified by Rosendahl and

Haun (1987) was relocated, and assigned a new SIHP number, site -24329. The wall was recommended for no further work (Haun and Henry 2005:14).

In 1991, William Barrera Jr. produced an AIS and data recovery report of an extensive area just inland (*mauka*/east) of the present study area in which he identified 61 sites (corresponding with the Wolforth et al. 2005 project area on Figure 12). These sites were rather clumped in the east-central portion of this project area.

In 1988, Cordy et al. (1991) began preparing a study of Kaloko Ahupua'a for the new Kaloko-Honokōhau National Park. The study was based on Renger's 1971 fieldwork conducted for planned development of coastal Kaloko for Huehue Ranch. The fieldwork "included survey work in the intermediate and upland zones of Kaloko, which located additional sites, extensive excavation in the coastal area, and some excavation in the intermediate and upland sites" (Cordy et al. 1991:2). Renger identified, and in some cases re-identified, 94 sites that included 59 sites in the Coastal Zone, 30 sites in the Middle Zone, and five *mauka-makai* trails that crossed both zones and continued heading inland. As only "summary papers" had been previously written, the monograph published in 1991 includes the 1971 fieldwork data and resultant analyses, and additional fieldwork conducted by Cordy and Hitchcock in the 1970s and 1980s (Cordy et al. 1991:2, 44).

Rosendahl and Walker (1991; not shown on Figure 12) carried out an archaeological field inspection for proposed Kaloko Industrial crusher sites just south of Hina Lani Street at an elevation of approximately 450 ft amsl. A trail and two associated cairns were identified.

In 1993, Paul H. Rosendahl Inc. conducted an AIS (Fager and Graves 1993; see Figure 12) of an approximately 15-acre parcel adjacent to, and *mauka* of, the Kaloko Industrial Park, which includes a road corridor extending from the main project area to Kamanu Street. The survey recorded 17 sites incorporating 60 component features. The sites were judged

> ...in poor to good condition and comprised the following formal types: terraces, modified outcrops, mounds, walls, caves, pahoehoe excavations, cairns, filled cracks, enclosures, and a trail. The formal types comprised the following functional types: animal husbandry, temporary habitation, agriculture, marker, quarry, and transportation [Fager and Graves 1993:ii].

In 1995, Cultural Surveys Hawai'i conducted an AIS with limited subsurface testing within a narrow strip of land, averaging 300 ft wide, along Queen Ka'ahumanu Highway between Palani Road and the Keāhole Airport entrance road (Walsh and Hammatt 1995; see Figure 12). Three sites were identified, but they were located in Kohanaiki to the north. The sites consisted of two trails and a set of three cairns.

In recent years a number of studies have been undertaken adjacent to and *mauka* of the present project area between 1000 and 2730 ft amsl, including studies by Barrera Jr. (1993), Nees & Williams (1995), Rechtman (1998), Rechtman and Henry (1999), Rosendahl (2000), Clark & Rechtman (2002), Rechtman and Rivera (2002), Puette & Dye (2003), Rechtman (2003), and Elmore et al. (2004) (not included on Figure 12). Many of these studies did not identify any historic properties, while others identified only a handful of pre-contact and/or historic-era sites. Barrera Jr. (1993) documented 40 features belonging to the Kona Field System

during an inventory survey covering approximately five acres situated between 1450 and 1650 ft amsl. Rechtman and Henry (1999) identified 15 sites in an AIS conducted at similar elevations.

The Nees and Williams (1995) survey covered 110 acres between 2,100 ft and 2,900 ft amsl in the Kaloko Mauka housing subdivision. Some of the project overlapped the Cordy et al. (1991) study area, in which formal fields between 900 ft and 2300 ft elevation were documented. The 1995 survey identified a wall, a possible pigpen, a modified outcrop, a possible burial mound, an area of mounds, an area of terracing, and a culturally modified lava tube containing a burial. No excavations were conducted. The report concluded that above 2,100 ft elevation agricultural features in Kaloko are isolated and scattered in areas best suited to agriculture.

A series of studies (Haun & Henry 2000, 2002, Haun et al. 2003; see Figure 12) were carried out on a 102-acre Kaloko Industrial Park parcel south of Hina Lani Street. Of note are the fairly dense and widely distributed site concentration and also extensive areas of both *'a'ā* flow and bulldozing. Data recovery occurred at eight temporary habitation sites (Haun et al. 2003). Charcoal samples from five of the eight sites were submitted for radiocarbon analysis (with the remaining three already dated during the inventory survey phase). Three of the sites (SIHP -21999, -22016, -22018) were potentially utilized by the mid-1400s. SIHP -22023 was determined to have multiple occupations spanning between A.D. 1500 and 1700. SIHP -22014 and -22017 were occupied during the late pre-contact period into the early post-contact period. Observed artifact and midden assemblages as well as structural modifications indicated a variety of activities conducted at the temporary habitation features. Activities determined to have been practiced at the data recovery sites included animal husbandry, water collection, fire construction, food preparation and consumption, and stone and bone tool manufacture.

In 2003, Archaeological Consultants of the Pacific, Inc. (Cobb et al. 2003; see Figure 12) conducted an archaeological assessment of TMK (3) 7-3-009: 025, 026, and 028. One hundred fifty-four (154) features were identified and included "caves, walls, mounds, platforms, enclosures, trails, cairn, "C"-shaped structures, possible *heiau*, terraces, alignments and modified outcrops" (Cobb et al. 2003:1). Each feature was identified with a number prefaced with "TF", and descriptions included feature type, a brief description, possible function and a preliminary significance evaluation. The report map does not show the location of particular sites found during the survey but has colored points for sites indicating "High Concern, Potential High Concern, and Minimal Concern" (Cobb et al. 2003:5).

In 2005 Wolforth et al. (see Figure 12) conducted an AIS of the northern portion of the Kaloko Heights Project (TMK [3] 7-3-09:032), located across Hina Lani Street north of the current project area, in a portion of the Barrera Jr. 1985 study area and overlapping the Barrera Jr. 1991 study area. A total of 89 sites were identified, consisting of burials, permanent habitations, temporary habitations, religious sites, trails, boundary walls, and agricultural sites. An historic wall was recorded that runs along the *ahupua'a* boundary between Kaloko and Kohanaiki, while historic wall site 10710 was recorded extending north from Hina Lani Street (see Figure 1). Two other sites (10685 and 10687) were recorded during this study in proximity to Hina Lani Street. Site 10685 is not discussed in the report. Site 10687 consists of a complex of three terraces; after testing at these features it was determined that they functioned agriculturally (Wolforth et al. 2005:42).

CSH completed an archaeological field inspection in 2005 of a 1200+ acre project area in Kaloko and Kohanaiki (TMK 7-3-009:017, 025, 026, and 028). Numerous pre-contact sites were observed, including habitations, agricultural features, petroglyphs, boundary walls, and burials (Shideler & Hammatt 2005; see Figure 12). These lands, which are *makai* of the present project area, would be revisited by CSH between 2007 and 2008 for archaeological inventory survey.

During the AIS of the 224+ acre project area at TMK 7-3-009:017 (Bell et al. 2008a; see Figure 12) a total of 59 historic properties were identified within the project area; 53 of the historic properties were previously identified and six were newly recorded during the inventory survey investigation. CSH had previously conducted an AIS (Colin et al. 1996) in the same project area in 1996 with limited subsurface testing for Kimura International; the project was terminated during the review process. Fifty-five (55) sites were identified in 1996. All identified sites were of pre-contact traditional Hawaiian origin and included the following site types: cairn, simple agricultural features, recurrent and temporary habitation sites, trails, enclosures, walls, and a quarry. During the 2007 inventory survey two sites (Site -20706 & -20741) identified by Colin et al. were determined to be outside of the project area, likely due to the lack of GPS technology during the 1996 survey.

Concurrently, CSH surveyed 363+ acres at TMK 7-3-009:028, along the south side of Hina Lani Street (Esh et al. 2008; see Figure 12), and 194+ acres at TMK 7-3-009:026 (Bell et al. 2009; see Figure 12). Between these two parcels, a total of 161 sites were documented, including 6 previously identified sites and 155 newly recorded sites. While the vast majority of these sites were of pre-contact traditional Hawaiian origin, a handful were determined to be historic. The types of sites observed in these project areas included complexes, walls, trails, lava tubes, mounds, enclosures, platforms and modified outcrops. Functional analysis yielded a wide range of uses, from agriculture and water collection to temporary and permanent habitation to burial. Charcoal samples taken from test excavations at five sites reflected land use falling between 1465 AD and 1954 AD.

Additionally, all 360+ acres comprising TMK 7-3-009:025 were surveyed by CSH in 2007-2008 (Bell et al. 2008b; see Figure 12). A total of 121 historic properties were identified. All of the sites were recommended for either data recovery or preservation. Making correlations with site identifications made by Kennedy (1984) was highly problematic and was generally not possible with any certainty. Two of the historic properties were clearly previously identified and 119 are regarded as effectively newly recorded as part of the current inventory survey investigation. The variety of site types observed in the TMK 7-3-009:025 study area are similar to those present in TMKs 7-3-009:026 and 7-3-009:028, described above. Temporary habitation sites were the most common, though transportation, permanent habitation, marker, animal husbandry, agriculture, burial, indeterminate, quarry, water collection, and ceremonial sites were also documented. While the subsurface testing conducted at 15 features helped to improve the functional interpretation of those sites, it did not yield any charcoal in good context for dating.

In 2008, CSH conducted a field inspection, AIS, and addendum survey (Yucha and McDermott 2008a and 2008b, Tulchin and McDermott 2009, respectively; see Figure 12) for the 108.8-acre northern-most portion of the proposed Ane Keohokālole Highway (Henry Street extension) in Kaloko and Honokōhau. The study area was situated between 300 and 440 ft amsl. A total of 33 historic properties were identified within the survey area, with a total of 179

features. Twenty of the historic properties were identified during previous AIS investigations (Esh et al. 2008; Robins et al. 2000), and comprised a total of 100 features, 70 of which were identified during the AIS investigation. Thirteen additional historic properties composed of 79 features were identified during the inventory survey investigation. All but three of the sites were considered to be pre-contact. Site types included (in order of highest to lowest occurrance): mounds, modified outcrops, pavements, enclosures, platforms, terraces, lava blisters, lava tubes, modified depressions, alignments, cleared areas, walls, cairns, trails, petroglyphs, a *papamū* [stone on which the checker-like game, *kōnane*, was played], a rockshelter, and a cattle trough.

3.2.2 Archaeological Study Conducted Within the Present Project Area

In 1985, Barrera Jr. (see Figure 12) surveyed approximately 409 acres within Kaloko and Kohanaiki. The 409-acre study area was located between Māmalahoa Highway and Queen Ka'ahumanu Highway just below the Kona Heavens subdivision; its portion north of Hina Lani Street was later covered during the Barrera Jr (1991) and Wolforth et al. (2005) surveys (see Figure 12). Four sites were recorded within Kaloko, including an enclosure (Site #1), a lava tube cave (Site #2), a wall (Site #3) and a platform potentially containing a burial (Site #4). Sites #2 and #3 are in relative proximity to the current project area (see Section 3.2.3). Fifty-five sites were recorded within Kohanaiki and include mounds, platforms, habitation complexes, walls, and terraces. A portion of the study area included the historic-period Kohanaiki Homestead, which was located about ¾ mile northeast of the current project area. Barrera's site #59 comprises constructions associated with the homestead and is described as a "series of Habitation areas enclosed by large stone walls." No estimate is given of the ages of the other fifty-eight sites.

Widespread disturbance was noted throughout the Kaloko portion of the 1985 study area. Barrera Jr. writes:

> The initial fieldwork in the Kaloko portion of the project area immediately led us to suspect that extensive clearing of the property had occurred in the recent past. This was indicated by the overwhelming numbers of such introduced plant species as haole koa...lantana...Guinea Grass...and Christmas Berry...as well as by the presence of extensive areas of fractured rocks. This suspicion was confirmed in interviews with employees of Huehue Ranch, the former owner of the parcel, who stated that initial clearing for pasture had occurred in the 1940s, and that subsequent clearing had occurred at least into the 1950s. For this reason, although sweeps through the area were conducted, the primary survey method in the Kaloko portion of the survey area consisted of cutting paths through the virtually impenetrable vegetation to those areas which appeared, on the basis of an aerial photograph supplied by R. M. Towill and Co., not to have been disturbed by the clearing. These consisted of small patches of mango and kukui trees which, because of their relatively large size, we felt might represent older growth that had been avoided during the clearing operations, and there was therefore a higher probability of remnant sites being found in those areas [Barrera Jr. 1985:6].

Barrera returned to the northern portion of this project area (across Hina Lani Street from the current project area) in 1988 and 1991 for subsequent studies.

3.2.3 Archaeological Sites Anticipated in Proximity to the Current Project Area

Two sites identified during the Barrera Jr. (1985) inventory survey are in proximity to the current project area. It is unknown at this time if these sites were ever assigned SIHP numbers. Both are located outside of but near the southwest corner of the current project area (Figure 13). Though these sites are not anticipated to be found within the present study area, there is a chance that one or both may be, given the lack of GPS technology when the sites were documented. It is not uncommon for sites recorded during older studies to be relocated over 100 m from their reported positions.

Barrera Jr.'s Kaloko Site #2 consists of a lava tube containing cultural modifications. Kaloko Site #3 is a short wall segment that may have once been part of a larger feature or site. The following site descriptions and mitigation recommendations are taken from the Barrera Jr. (1985) report.

3.2.3.1 Kaloko Site #2

Description (from Barrera Jr. 1985:9-11)

This is a lava tube cave containing three stone terraces and a crude stone wall (Figure 14). The modified portion of the cave, the ceiling of which stands to a height of over 3 meters, measures about 9 by 10 meters. An ashy deposit contains the Shells of two nerites, one marine species [*Nerita picea*] and one brackish-water species [*Theodoxus sp.*], and two species of cowrie [*Cypraea mauritiana* and *C. caputserpentis*], echinoderm spines and tests, the bones of a medium to large bird and a large mammal, and two fragments of coral. The scattered skeleton of a pig, probably of very recent vintage, is also present. Four features were recorded.

Feature A - This is a stone terrace measuring 2.5 by 7 meters, the retaining wall of which stands to a height of 1.25 meters. The west end of the feature has collapsed onto the surface of Feature B.

Feature B - This is a stone terrace measuring 2 by 8 meters, the retaining wall of which stands to a height of 75 centimeters.

Feature C - This is a stone wall measuring 5.5 meters in length. It is 65 centimeters wide, stands 50 centimeters high, and is approximately bisected by a 70-centimeter-wide gap. The western three-quarters of the feature rest directly on the cave floor, the eastern quarter is built on Feature D.

Feature D - This is a stone terrace measuring 1 by 1.5 meters and standing to a height of 1.2 meters.

Recommendation (from Barrera Jr. 1985:39)

This habitation cave is an extremely valuable site for two major reasons. One is that it is one of the few remnants of the complex of sites that undoubtedly existed in the area before pasture clearance. The second is that, because it is a cave, it is likely to contain relatively better preserved remains than would be found in an open site under the same climatic conditions. It is our recommendation that this site be archaeologically excavated prior to any construction activities.

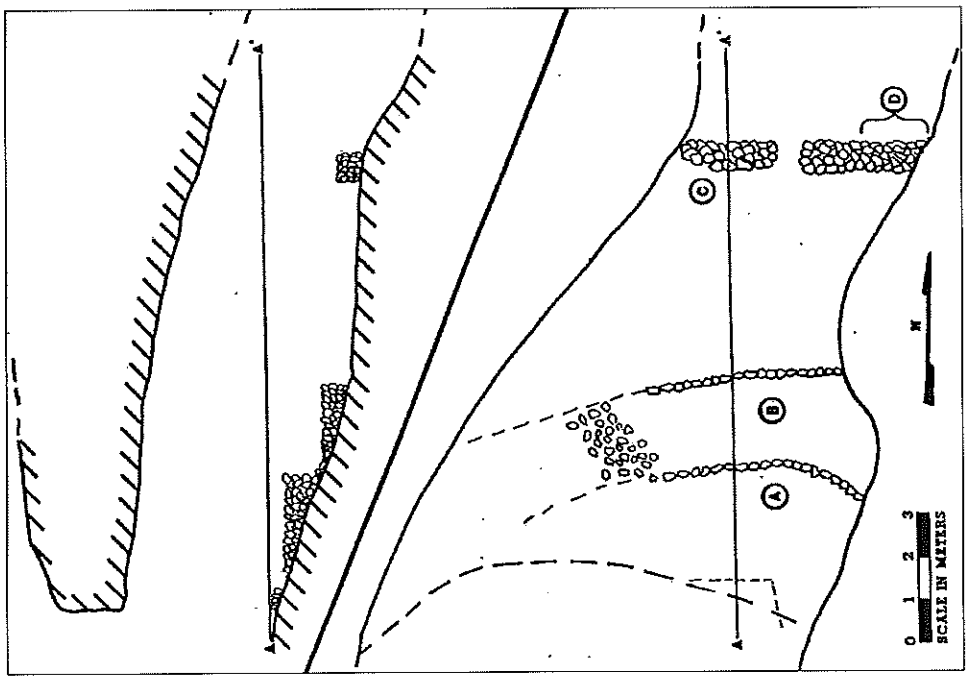

Figure 14. Plan view map of Kaloko Site #2; from Barrera Jr. (1985:10)

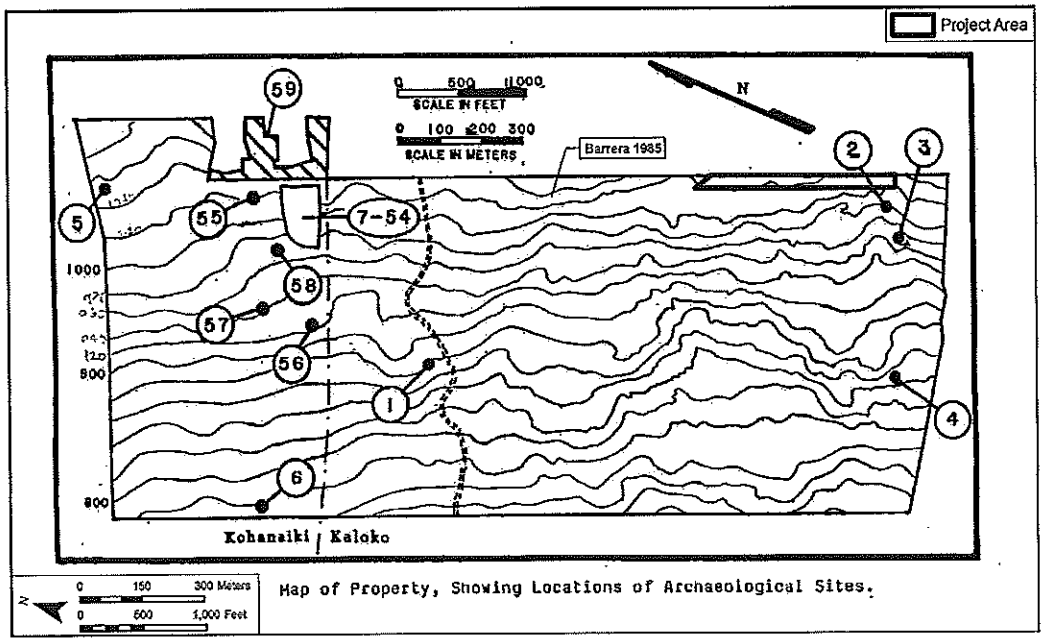

Figure 13. Map from Barrera Jr. (1985:7) overlain with the present project area, showing the approximate locations of previously-identified sites

3.2.3.2 Kaloko Site #3

Description (from Barrera Jr. 1985:11)

This is a linear wall, possibly the remains of a housesite, measuring 1 meter in width, 5.3 meters in length, and standing to a height of 1.1 meters (Figure 15 and Figure 16). A possible paving is located on the northeast side of the wall, but bulldozing around that side of the feature has destroyed any evidence of associated remains.

Recommendation

Barrera Jr. (1985:39-40) recommended testing at this site of indeterminate function "to determine if there are any excavatable deposits present. If such deposits are found, we recommend that archaeological excavations be conducted prior to any construction."

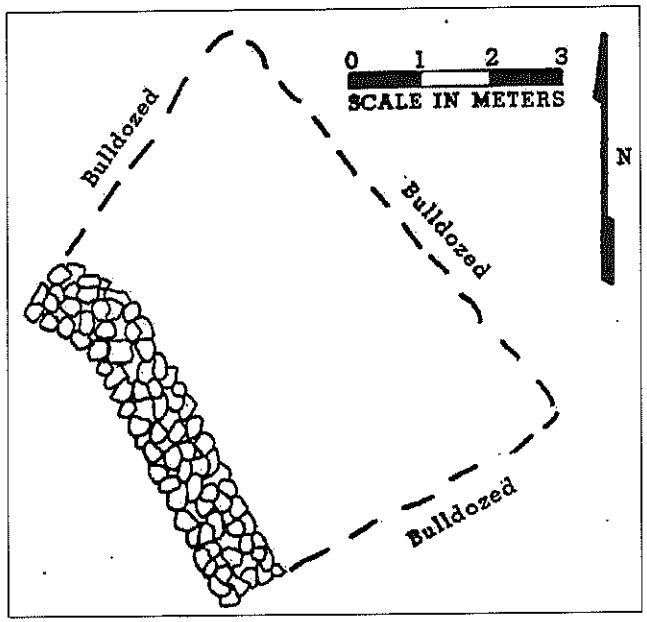

Figure 15. Plan view map of Kaloko Site #3; from Barrera Jr. (1985:11)

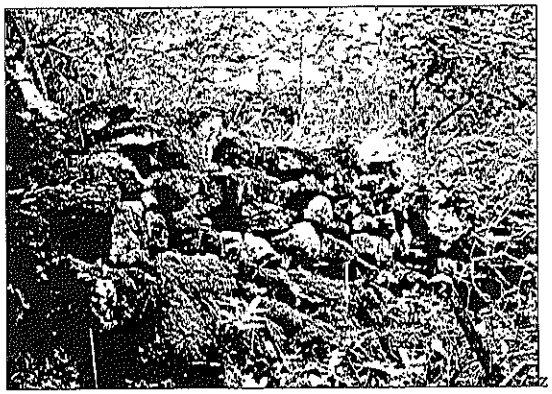

Figure 16. Photo of Kaloko Site #3, view to the southeast; from Barrera Jr. (1985:12)

3.3 Background Summary and Predictive Model

3.3.1 Background Summary

Kaloko Ahupua'a is located within the Kekaha region of North Kona. The Kekaha region, or "Kekaha-Waiole, the desolate land without water" (Kelly 1973:74) refers to the barren lava fields extending north from Kailua-Kona to Anaeho'omalu (Kelly 1973:74).

Elevation is a critical factor in trying to understand the traditional background of the Kekaha region of North Kona. *Kānaka Maoli* (Native Hawaiians) employed a variety of activities across all of the land use zones during the prehistoric and early historic period. The original settlement of Kaloko was focused on the coast starting around 900 A.D. (Cordy et al. 1991). These earlier settlers were likely drawn to the coast by the presence of potable water found in the brackish ponds, the excellent fishing, and one of the most protected inlets on the Kona Coast (Cordy et al. 1991:575).

Radiocarbon dates from the Kekaha region may indicate that all three zones of Kaloko Ahupua'a were utilized to some degree or another as early as A.D. 1280 (Walker and Haun 1988). This period of time correlates with an apparent population increase and geographical expansion in the Hawaiian Islands identified as the "Expansion Period" (Kirch 1985:303) or the middle of the "Pioneer Settlement" (Schilt 1984:276). Permanent settlement continued to be centered on the coast and agriculture developed upland as the endemic forest lands were gradually reduced by slash-and-burn methods.

Development of the intensive upland agricultural system probably occurred between ca. A.D. 1400 and 1650 (Schilt 1984:277) and focused along the more prime agricultural lands found at elevations where soil was abundant and rainfall sufficient for productive cultivation. During this

period permanent settlement continued to be centered at the coast but also began to be developed in the upland localities of Kaloko, as the distance between the upland farms and original coastal settlement expanded. By the end of this period it is expected that most of the upland permanent habitations were occupied. The fishponds in Kaloko were likely constructed during this period, and concurrently a four class hierarchy of "ruler, high chiefs, local chiefs and commoners" was formed in Hawai'i (Cordy et al. 1991:575).

During early historic times (ca A.D. 1800-1840) following western contact, the Kaloko population undoubtedly declined rapidly due to disease, and a major shift in the traditional Hawaiian settlement pattern. The residents who survived disease likely shifted their residences to economic centers such as Kailua-Town, or in closer proximity to major roadways and localities of churches and schools established by the missionaries.

Following the Māhele (ca 1850's), the Kaloko shoreline was virtually abandoned "with the Kohanaiki Homesteads the new upland population focus in the Kaloko area" (Cordy et al. 1991:580). As a result, the vacant lands were subsequently acquired for cattle ranching. Throughout the 19th century, use of the lands around the project area would likely have been limited to activities associated with the operations of the Huehue Ranch.

During the mid-20th century Huehue Ranch cleared the project area lands for use as pasture. In modern times, major developments within Kaloko have occurred outside of the project area, which remains undeveloped. These developments are predominantly centered around the Queen Kaahumanu Highway and the Koloko Industrial Area to the west, though Hina Lani Street and the Kona Heavens housing subdivision represent modern developments immediately adjacent to the project area. The construction of the Kona Heavens subdivision in the 1970s may have also impacted the project area.

3.3.2 Predictive Model

The location of the current project area in the Upland Zone places it within an area of pre-contact Hawaiian habitation and activity associated with agriculture. It is thus suggested that traditional Hawaiian sites likely to occur within the project area would include permanent habitations, *heiau* or *ahu* (altars or shrines), agricultural activity areas, *mauka-makai* trails connecting coastal residences and upland agricultural areas, with branch trails extending to specific use areas within the project area; and burial sites utilizing features of the terrain, including lava tubes and cracks.

Historic sites potentially located within the project area would include features related to the Huehue Ranch or to the pattern of historic habitation centered around the Kohanaiki Homesteads.

The history of land disturbance in the portion of Kaloko including the project area may have disturbed or completely obliterated remains of such pre-contact or historic features discussed above. It is unclear what method(s) of clearing was/were employed by the Huehue Ranch, and the Barrera Jr. (1985) survey did not cover 100% of the study area. Therefore, despite the history of prior land disturbance, there still remains some potential for undocumented, archaeologically significant features.

Sites already documented adjacent to the project area confirm the predictive model above. Kaloko Site #2 is a modified lava tube that may have functioned as a habitation site or an activity area. The Barrera Jr. (1985) site description for this lava tube is somewhat vague; if the site is relocated during the present study the tube will be documented in further detail if necessary. This work will serve to definitively rule out the possibility of human burial within the lava tube or its associated features. Kaloko Site #3 may be part of an agricultural- or habitation-related site, or could be related to ranching operations conducted in the area. Again, if this site is relocated during the present study, further documentation may provide further insight.

Section 4 Results of Fieldwork

4.1 Survey Findings

The fieldwork component of this archaeological assessment was accomplished on July 5, 2011 by CSH archaeologists Johnny Dudoit, B.A. and Olivier Bautista, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. (principal investigator). The fieldwork consisted of complete coverage of the project area, accomplished with several north-south oriented transects spaced five to ten meters apart. Ground visibility was generally moderate, but varied given the different types of vegetation encountered (Figure 17 and Figure 18).

No historic properties were identified within the approximately 3.44-acre project area. The lack of findings is consistent with the extensive land disturbance that occurred in this area beginning in the 1940s. This disturbance surely obliterated any pre-contact features or historic sites related to settlement around the Kohanaiki Homesteads that may have once been present here. Barrera Jr.'s (1985) Kaloko Sites #2 and #3 were not presently relocated, indicating that they do indeed lie outside of the project area.

Evidence of ground disturbance throughout the project area includes the presence of scarring along *pāhoehoe* exposures, likely the result of bulldozing or chain-dragging, and numerous bulldozer "push piles" (Figure 19). The portion of the project area correlating with the disturbed area shown on the 1978 Orthophoto (see Figure 11) appeared more even, or level, than the southern third of the project area. The decades-long presence of livestock in the project area may also account for some of the disturbance noted during the current fieldwork.

Generally the ground surface was characterized by jumbled cobbles and boulders set amongst *pāhoehoe* outcroppings and soil deposits (Figure 20). Some of the soil areas have been rooted by pigs (Figure 21). Numerous pig trails were observed, as were recent cattle droppings. The *makai* boundary of the residential lot at the Hina Lani Street and Halolani Street intersection is not fenced (Figure 22), and there is evidence that pigs are tended here but are allowed to roam freely into the project area lands. The other lots on the *makai* side of Halolani Street are fenced. Along this eastern edge of the project area trees have been cut back and/or cleared entirely, apparently to allow for improved views of the coastline.

Assorted modern rubbish and piles of yard waste were found scattered throughout the project area, including plastic pots and buckets likely used for illicit marijuana cultivation (Figure 23). Most of the rubbish and plant waste was likely deposited by local residents and from vehicles traveling on Hina Lani Street, as there was no indication of squatters or temporary camps.

Near the unfenced house at the Hina Lani Street and Halolani Street intersection, a modern enclosure was observed (Figure 24). This enclosure, constructed of local cobbles and boulders, may have been built for an agricultural purpose, though its proximity to Hina Lani Street indicates that it was not likely used in association with marijuana cultivation. Many plants were observed throughout the project area that were likely propagated by local residents or via the excrement of animals such as feral pigs (see Section 1.3.1).

Figure 17. Photo showing the dense *koa haole* growing along the Hina Lani Street shoulder, view to the east

Figure 18. Photo showing an area of thick grass and Christmasberry in the interior of the project area; view to the southwest

Figure 19. Photo of bulldozer push piles typical within the project area; view to the south

Figure 20. Photo showing a characteristic soil deposit, *pāhoehoe* exposure and area of jumbled rock material (foreground under vegetation); view to the west

Figure 21. Photo of a soil deposit within the project area that has been disturbed by pigs; view to the west

Figure 22. Photo of the unfenced boundary between the residential lot at the Hina Lani Street and Halolani Street intersection and the project area; view to the south

Figure 23. Photo of a rubbish pile encountered in the project area that includes yard waste; view to the southeast

Figure 24. Photo of the modern enclosure found within the project area in proximity to Hina Lani Street; view to the southwest

Section 5 Project Effect and Mitigation Recommendations

5.1 Project Effect

No historic properties were identified within the approximately 3.44-acre project area. Mechanical clearing related to the operations of Huehue Ranch and the construction of the Kona Heavens subdivision likely destroyed or severely impacted any surface historic properties that may have existed within the project area.

Consequently, CSH's effect recommendation for the proposed project is "no historic properties affected."

While no surface historic properties were identified during the current archaeological inventory survey investigation, the potential for subsurface features (in particular, modified lava tubes) still remains. Modifications can occur deep in lava tubes that may not have openings to the surface within the bounds of the project area.

5.2 Mitigation Recommendations

No historic preservation mitigation measures are recommended for the proposed project and no further archaeological work is warranted. In the unlikely event that cultural deposits, lava tubes or human remains are encountered during the course of project-related ground disturbance, all work in the immediate area should stop and SHPD/DLNR should be promptly notified.

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Appendix L

Cultural Impact Assessment for Kaloko Makai
Cultural Surveys Hawaii, Inc.
May 2008

Draft

Cultural Impact Assessment for a 1,150-Acre Parcel within portions of Kohanaiki and Kaloko Ahupua'a, North Kona District, Hawai'i Island TMK: [3] 7-3-009:017, 025, 026, 028

Prepared for

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Management Summary

Reference	Cultural Impact Assessment for a 1,150-Acre Parcel within Portions of Kaloko and Kohanaiki Ahupua'a, North Kona District, Island of Hawai'i, TMK: [3] 7-3-009:017, 025, 026, 028 (Magat et al. 2008)
Date	May 2008
Project Number (s)	Cultural Surveys Hawai'i Inc. (CSH) Job Code: KOHANAIKI 1
Agencies	State of Hawai'i Department of Land and Natural Resources / State Historic Preservation Division (SHPD)
Project Location	The project area is comprised of TMK: [3] 7-3-009:017, 025, 026, 028. The project area is located in portions of Kaloko Ahupua'a and Kohanaiki Ahupua'a, and the west boundary is approximately 1300 meters east from the western coast of Hawai'i. The project area is bound by Queen Ka'ahumanu Highway to the west, by undeveloped parcels to the east, 'O'oma 2nd Ahupua'a to the north with Huliko'a Drive north of the *makai* portion, and "Kaloko Industrial" or "New Industrial" south of the *makai* portion. The surrounding parcels are largely undeveloped. Hina Lani Street runs *mauka/makai* through the project area. This area is depicted on the 1996 USGS 7.5-Minute Series Topographic Map, Keahole Point and Kailua Quadrangles (Figure 1).
Land Ownership	Private, Stanford Carr Development Kaloko Makai, LLC
Project Description	The proposed project comprises the development of a residential subdivision with limited retail establishments near Queen Ka'ahumanu Highway. Associated ground disturbance will include grading and excavation related to the project area's development, to include engineering topography, placement of structural footings, utility installation, roadway, parking area installation, and landscaping. Importation of substantial construction gravel and fill dirt will also likely accompany much of the construction.
Project Acreage	The CSH project area consists of approximately 1,150 acres.
Area of Potential Effect (APE)	For the purposes of this cultural impact assessment (CIA), the APE is defined as the approximately 1,150-acre project area footprint. While this investigation focused on the project APE, the study area also included portions of the *ahupua'a* of Kohanaiki and Kaloko.
Document Purpose	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 cultural practices. At the request of Stanford Carr Development, LLC, CSH undertook this CIA. Through document

	research and cultural consultation efforts, this document provides information pertinent to the assessment of the proposed project's impacts to cultural practices (per the OEQC's Guidelines for Assessing Cultural Impacts). The document is intended to support the project's environmental review and may also serve to support the project's historic preservation review under HRS Chapter 6E-42 and Hawai'i Administrative Rules (HAR) 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 Hawai'i Island Burial Council (HIBC), and community and cultural organizations in the North Kona area. A total of twenty-five people were contacted for the purposes of this CIA; 18 people responded; and 12 *kūpuna* and/or *kama'āina* were interviewed for more in-depth contributions. At this writing, a total of nine of these individuals have consented to have their testimonies included in this report. Efforts to obtain permission to include the testimonies of the remaining three individuals who were interviewed for this CIA are ongoing.
Results	Background research conducted for this project yields the following results: 1. The project area is part of the traditional region known as Kekaha, extending from Honokōhau to 'Anaeho'omalu in North Kona. Despite being a dry place, the project area contains many unique resources—including dozens of subterranean lava tubes and caverns used to collect water; the project area included an extensive pre-Contact Hawaiian settlement that continued to support a subsistence-based lifestyle into the early historic era. 2. Archaeological research shows the project area contains hundreds of culturally and historically significant sites and thousands of individual features within these sites. Sites in the project area include permanent and temporary habitation structures—many of which incorporate natural features of subterranean lava tubes into their design, agricultural features (including extensive rock mounds used to plant sweet potatoes), at least 65 burials located in approximately two dozen burial sites, *ahu* (stone markers), trails, petroglyphs, *ahupua'a* boundary walls, *papamū* (traditional gaming site), and others. 3. Radiocarbon dating from nearby sites definitively shows the general area has been utilized by humans for at least 1,000 years.

	4. The project area is likely to contain substantial additional subsurface deposits—as yet undiscovered and undocumented—associated with lava tubes and subterranean chambers, including burials and other highly sacred materials. 5. The project area is also associated with the unique history of Hawaiian-style ranching and *paniolo* ("Hawaiian cowboys"), including the well-documented Hu'ehu'e Ranch. 6. The project area is associated with specific *mo'olelo* (oral history) about (a) the sixteenth or seventeenth century ruler of Hawai'i Island, Lono-i-ka-makahiki, who was involved in several famous battles with the chiefs of Maui (including Kama-lala-walu) and other parts of Hawai'i, (b) Kamehameha I, whose remains were reportedly interred near Kaloko Fishpond, (c) 'Umi-a-Liloa, who frequented the famous fisheries of Kaloko and Kohanaiki, and (d) the Nahulu chiefs (including Ka-me'e-ia-moku and Ka-manawa). The project area is also associated with legendary references to Ka-Miki, various *mo'o* (water spirits) that resided at fishponds at and near the seashore, and Hualālai; and more general references to water-collection lava tubes and the unique environmental conditions of the region. Community consultation conducted for this project yields the following results: 1. Several participants voiced negative feelings and opinions about the overall cumulative impacts of ongoing and future developments in Kona District and the project area environs pointing out such factors as a diminished quality of life for locals, dwindling resources, prices beyond the reach of most kama'āina and overtaxed infrastructure as contributing to a loss of what is authentic and traditional about Kona. 2. Several participants talked about subsistence resources that were previously available to, and enjoyed by, locals—such as various *limu* (seaweeds), crabs and fish—but that are no longer available or easily accessed due to the cumulative impacts of development in Kona. 3. Most participants talked about the presence of burials and *iwi kūpuna* (ancestral remains) throughout the project area. It is clear from some of the interviews that there are many lineal and/or cultural descendents to some of these burials that should be consulted during the proposed development, since some historic-era family burial sites, in particular, may be impacted by the subject project. 4. A few participants talked specifically about changing patterns of vegetation and plant life, highlighting the loss of native and

	Polynesian-introduced species as well as useful historic introductions such as mango trees. In particular, there is a remnant area of lowland forest in the project area containing several endangered and threatened native species, including *ko'oko'olau* (*Bidens spp.*). It is important to understand that such natural resources are significant cultural and historical resources to many native Hawaiians. 5. A few participants talked about drinking from water collection caves in historic times, as they moved around the landscape (e.g., as ranchers), and of brackish pools used by their animals (e.g., cattle and horses). 6. Several individuals discussed trails in the project area, including a historic trail running from the ocean to the mountains (this is the so-called "Road to the Sea") along the *ahupua'a* boundary between Kaloko and Kohanaiki, that were used in the recent memories of some participants to gather resources from the sea and the uplands. Given many changes and modern developments, most of the trails in the project area have not been used by many people for several decades.
Recommendations	The following recommendations are based on a synthesis of all the information gathered during preparation of this CIA. Faithful attention to these recommendations, and efforts to develop appropriate measures to address these concerns, will help mitigate the adverse impacts of the proposed action on Hawaiian cultural beliefs, practices and resources by the project: 1. Most of the people who voiced negative feelings and opinions about the overall cumulative impacts of ongoing and future developments in Kona District stopped short of saying they were entirely opposed to the proposed project; however, some participants recommended the project proponent prepare a draft Master Plan for review and comment by the public so that the various short- and long-term cumulative impacts, both negative and positive (e.g., the construction of recreational facilities and/or parks and other "green spaces"), can be assessed by the community. 2. Several participants, including the Office of Hawaiian Affairs (OHA), recommend the project proponents work together with the local community in order to develop plans that are *pono* (i.e., harmonious with the local environment), culturally sensitive and fair and balanced with respect to the *'āina* and its natural and cultural resources. 3. Efforts should be made to protect and preserve brackish water pools and water collection lava tubes.

	4. Most participants strongly urged that no burials or *iwi kūpuna* (ancestral remains) should be relocated or moved to make way for the proposed project. 5. One participant who worked as a *paniolo* for many years recommended preservation and protection of "holding corrals" (*puakini*) in order to educate present and future generations about the unique Hawaiian-style "cowboys" that flourished in and around the subject project area in historic times. 6. Efforts should be made to preserve and protect all trails in the project area, including designing around trails to maintain an authentic sense of place that is unique to Kona. 7. Efforts should be made to preserve and protect the remnant lowland forest and any other native and Polynesian-introduced plants species in the project area, including *ko'oko'olau* plants and other endangered and threatened species. Preparation of a "vegetation master plan," which could be combined with the next item (below), would help guide plans and commitments to preserve and protect these unique resources. 8. Several participants stated that, if the proposed development goes forward, it should use environmentally-appropriate landscaping that enhances the sense of place, including native and Polynesian-introduced species. Preparation of a "vegetation master plan," which could be combined with the previous item (above), would help guide plans and commitments to preserve and protect these unique resources. 9. OHA, in particular, recommends the project proponents faithfully follow all applicable laws with respect to the treatment of all historic properties located within the subject project area. 10. Cultural monitoring should be conducted during all phases of development, including all significant ground disturbances, to ensure that significant cultural and historical resources are protected and preserved in accordance with appropriate mitigation plans. 11. Community members and groups responsible for the long-term care of the Kohanaiki and Kaloko Ahupua'a, as well as cultural practitioners who utilize the area for gathering and for cultural and educational activities, should be further consulted regarding the above issues and other concerns throughout the planning, development and operation of the proposed housing development. This consultation should include all interested community groups and individuals who have a stake in the project area.

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Section 1 Introduction

1.1 Project Background

At the request of Stanford Carr Development, LLC, Cultural Surveys Hawai'i, Inc. (CSH) conducted a cultural impact assessment (CIA) of a 1,150-acre parcel within portions of Kaloko Ahupua'a and Kohanaiki Ahupua'a, North Kona District, Hawai'i Island, TMK: [3] 7-3-009:017, 025, 026, 028. The project area's west boundary is 1300 m east of the western coastline of Hawai'i. The project area is bound by Queen Ka'ahumanu Highway to the west, by undeveloped parcels to the east, 'O'oma 2nd Ahupua'a to the north with Huliko'a Drive north of the *makai* portion, and "Kaloko Industrial" or "New Industrial" south of the *makai* portion (Figures 1-4).

The 1,150-acre is privately owned by Stanford Carr Development Kaloko Makai, LLC. The proposed project comprises the development of a residential subdivision. Associated ground disturbance will include excavation related to the project area's development, to include structural footings, utility installation, roadway, parking area installation, and landscaping.

The purpose of the CIA is to consider the effects that the proposed project may have on the culture of Hawai'i, and traditional and customary rights. The Hawai'i State Constitution, Article XII, Section 7 protects "all rights" of native Hawaiians that are "customarily and traditionally exercised for subsistence, cultural and religious purposes." Act 50 (SLH 2000) was passed as an attempt to balance the scale between traditional lifestyles and development and economic growth. Act 50 provides that environmental impact statements: (1) Include the disclosure of the effects of a proposed action on the cultural practices of the community and State; and (2) Amend the definition of "significant effect" to include adverse effects on cultural practices.

The scope of work was designed to meet the Guidelines For Assessing Cultural Impacts as adopted by the Office of Environmental and Quality Control (OEQC) (1997), as well as the requirement of any other State and County agencies involved in the review process for the proposed project. The "Guidelines for Assessing Cultural Impacts" issued by the OEQC discuss the types of cultural resources, practices and beliefs that might be assessed. The Guidelines state:

> The type of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man-made and natural, including submerged cultural resources, which support such cultural practices and beliefs.

The assessment also considers cultural resources, practices and beliefs within the broader context of Kaloko Ahupua'a and Kohanaiki Ahupua'a that are relevant to assessing the role of the project area.

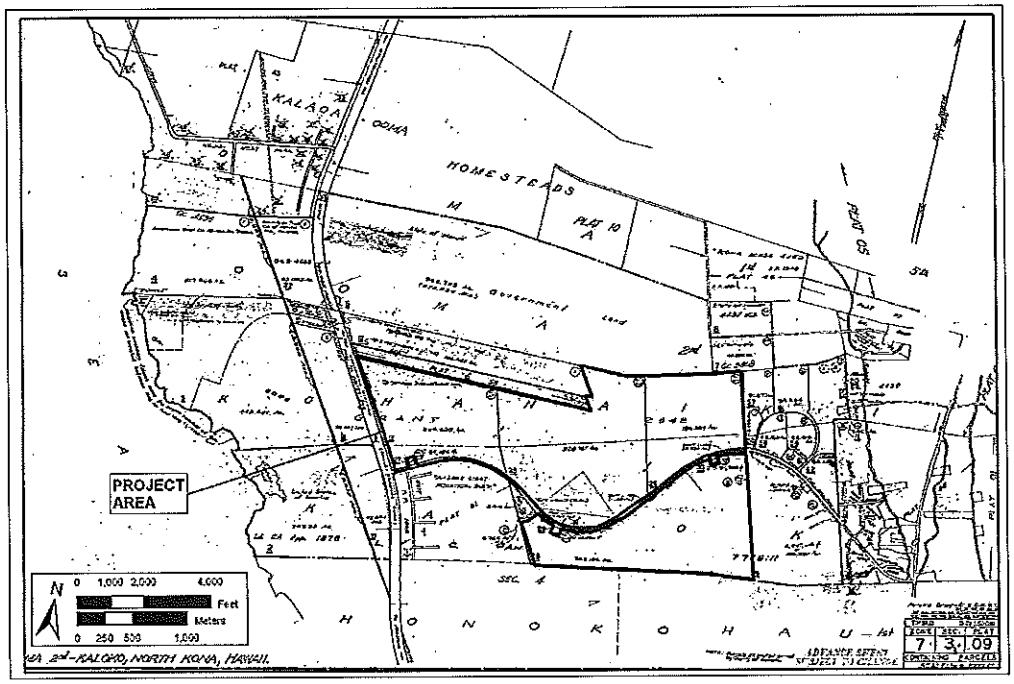

Figure 2. Tax Map Key (TMK) showing project area

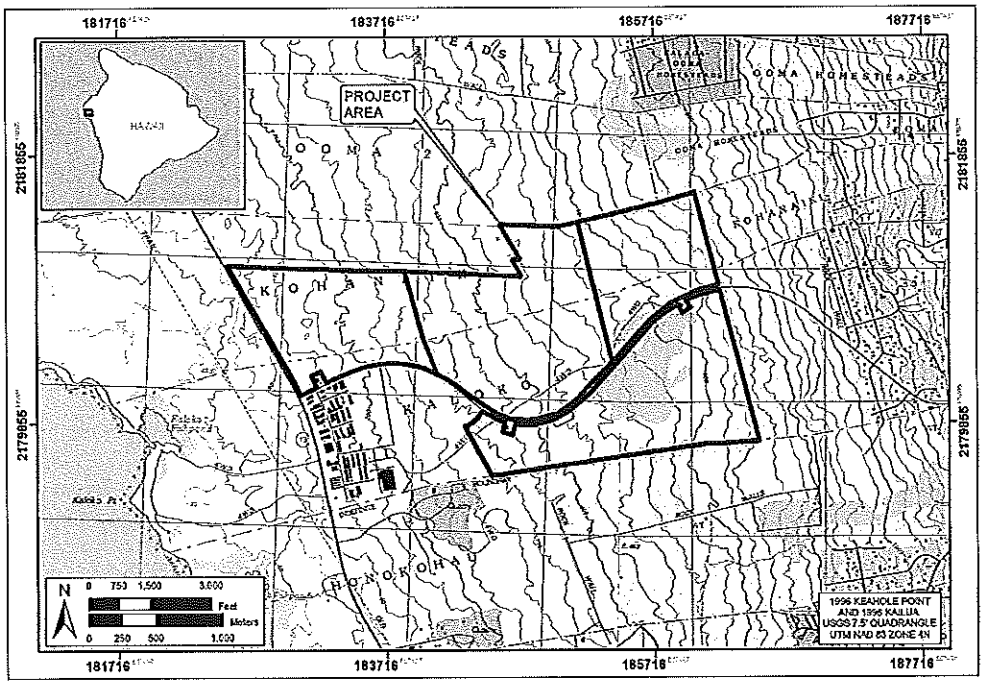

Figure 1. U. S. Geological Survey Quad Map showing project area

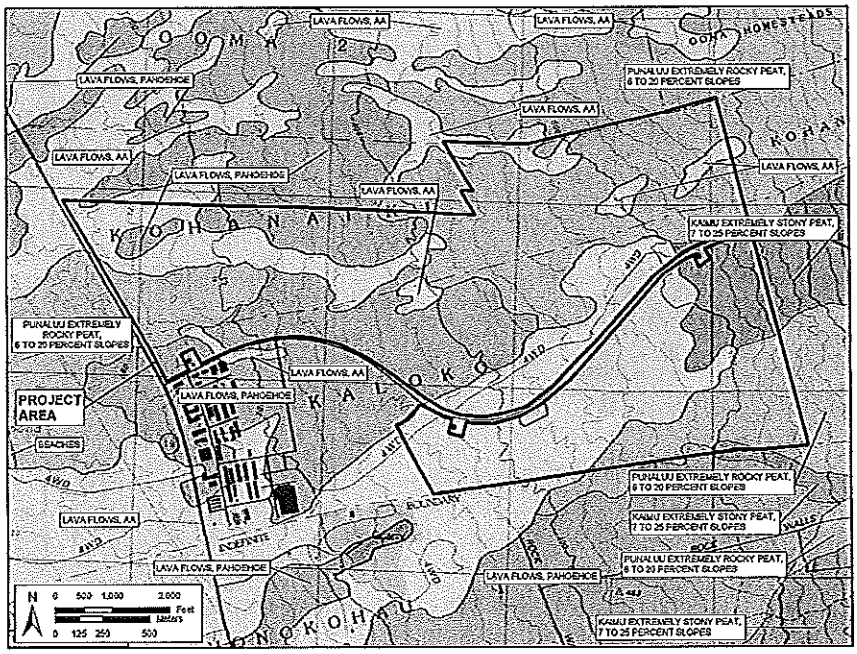

Figure 4. Soil map of the project area and vicinity

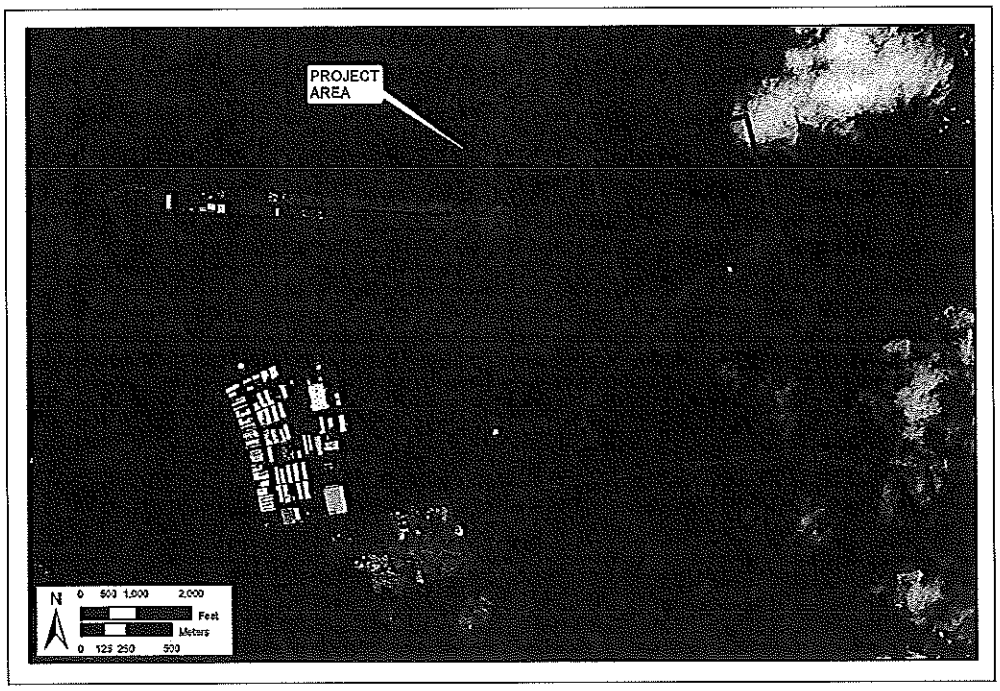

Figure 3. Aerial view of project area (source: USGS Orthoimagery 2005)

1.1.1 Archaeological Inventory Survey

An archaeological inventory survey including a surface survey, subsurface testing, and laboratory analysis of cultural and radiocarbon-dating materials was conducted for the project area. Given the large size of the project area, a decision was made to split the archaeological inventory survey reports by individual TMK parcel, producing a total of four reports.

1.2 Scope of Work

The scope of work for the CIA includes:

1. Examination of historical documents, Land Commission Awards, 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 sites on the property as they may allow us to reconstruct traditional land use activities and identify and describe the cultural resources, practices and beliefs associated with the parcel and identify present uses, if appropriate.
3. Conduct oral interviews with persons knowledgeable about the historic and traditional practices in the project area and region.
4. Preparation of a report on items 1-3 summarizing the information gathered related to traditional practices and land use. The report will assess the impact of the proposed action on the cultural practices and features identified.

1.3 Environmental Setting

1.3.1 Natural Environment

The project area comprises approximately 1,150 acres in the *ahupua'a* of Kaloko and Kohanaiki. The lands are located on the leeward coast of Hawai'i Island within the district of North Kona on the lower west slope of Hualālai Volcano. The project area is bounded by Queen Ka'ahumanu Highway to the west, Hina Lani Street to the south, TMK [3] 7-3-009:032 to the east, and 'O'oma 2nd Ahupua'a to the north. Elevation within the project area ranges from 80 ft. above mean annual sea level (a.m.s.l.) at the western boundary to 760 ft. a.m.s.l. along the eastern boundary.

Kona weather is typified by afternoon showers brought on by warm air that has been moved inland by light sea breezes. The humid air gradually condenses over higher altitudes throughout the day. At night, the land cools resulting in breezes which send warm air back out to sea. Rainfall in the project area averages 10 inches per year (Cordy et al. 1991). There are no natural springs or perennial streams within the project area, but dozens of subterranean water-collection lava tubes have been identified during archaeological survey by CSH.

The land surface is comprised of a large *'a'ā* flow running *mauka/makai* through the project area with several smaller flows to the northeast and a large flow in the northwest portion of the

project area (see Figure 4). The surface of the *'a'ā* lava ranges from roughly level expanses to rough fractured ridges.

Pāhoehoe lava covers the west-central and north-central sections of the project area. The surface ranges from level expanses to highly fractured tumultuous areas and is characterized by numerous tumuli and pressure ridges with depressions or undulations in the *pāhoehoe* containing thin soil pockets. Collapsed portions of lava tubes also contribute to the uneven surface of the *pāhoehoe* flows.

Punaluu extremely rocky peat is the dominant soil type in the project area (see Figure 4). Punaluu soils consist of well-drained, thin organic soils over *pāhoehoe* lava bedrock. The soils are gently sloping to moderately steep. The natural vegetation associated with this soil type consists of *koa haole* (*Leucanena glauca*), Christmasberry (*Schinus terebinthifolius*), guinea grass (*Panicum maximum*), natal redtop (*Rhynchelytrum repens*), and sand bur (*Cenchrus echinatus*). These soils are used for pasture (Sato et al. 1973). Both slope and soil development increase considerably with elevation.

In general, vegetation (especially ground cover) is dense throughout most of the project area and obscures ground visibility. The non-native *koa haole* tree dominates the project area vegetation along with the non-native air plant (*Kalanchoe pinnata*), non-native Christmasberry trees and grasses (predominately non-native fountain grass, *Pennisetum sectacacum*). The native *pili* grass, *Heteropogon contortus*, may also be present. At higher elevations, Christmasberry becomes more dominant, often growing in dense thickets that seriously impede pedestrian passage and greatly decrease ground visibility. Other non-native plants observed include lantana (*Lantana camara*) and *liliko'i* (*Passiflora edulis*). Native plants present include: *'ilima* (*Sida fallax*) in scattered numbers, *noni* (*Morinda citrifolia*), *'ōhi'a* trees (*Metrosideros polymorpha*), *laua'e* (*Phymatosorus scolopendria*), *'ohe* trees (*Reynoldsia sandwicensis*), *alahe'e* (*Psydrax odorata*), *kukui* (*Aleurites moluccana*), *kī* (*Cordyline fruticosa*; also often referred to as *tī*) and *halapepe* (*Pleomele spp.*). Native plants observed at higher elevations include: *naio* (*Myoporum sandwicense*), *'a'ali'i* (*Dodonaea sp.*) and *'ūlei* (*Osteomeles anthyllidifolia*).

1.3.2 Built Environment

Although much of the land around the project area remains rural, the built environment is distinct on the north and west sides of the parcel (see Figure 3 above). The built environment is distinct near the Queen Ka'ahumanu Highway, *makai* of the project area. To the north of the project area is a light industrial area bordering Huliko'a Drive built after the Colin et al. (1996) study. This area is marked by the Matsuyama Market and Pine Tree Cafe near the intersection of Huliko'a Drive and the highway. The area is marked by a stone sign "Kohanaiki." Today the industrial area is nearly complete, although some construction continues.

Hina Lani Street, a major coastal/inland (*makai/mauka*) connector road, runs through the center of the project lands. Two 1-million-gallon water tanks and a fairly large base yard have been developed along Hina Lani Street and are convenient points of reference. South of the *makai* (west) portion of the project area is a large industrial area often referred to as "Kaloko Industrial" or "New Industrial" (in reference to an older industrial area near the old Kona airport). This area features numerous large warehouses, light industrial and commercial buildings

(Home Depot and Costco, among others). As of the writing of this report, construction has commenced on additions to this commercial/industrial area *mauka* of the existing warehouses.

The project lands themselves are generally undeveloped, and appear not to have been dramatically impacted by modern activity other than bulldozing. Some modern cattle ranching has apparently taken place intermittently within the project area, with some barbed-wire fencing and a wooden trough present; the historic *ahupua'a* wall that runs through portions of the project area is also a good indication that historic animal husbandry occurred in the area. Modern trash and occasional transient camps were found near some historic properties, but generally this type of modern disturbance is concentrated near Hina Lani Street. However, portions of the *'a'ā* and *pāhoehoe* flows throughout the project area have been bulldozed, and bulldozer roads and intermittent bulldozing activity are present. A large portion of the bulldozing on *pāhoehoe* areas is probably related to the ranching activities. There are additional swaths of bulldozing on the *'a'ā* around the water tanks located on Hina Lani Street and at the large base yard off of Hina Lani Street. Most bulldozer activity tends to be concentrated either near Hina Lani Street, near the southern *ahupua'a* wall, or near barbed-wire fences within the central portion of the project area. There are a few distinct bulldozer roads in the project area, but less distinct signs such as bulldozer tread scars on bedrock were also noted in various locations.

A jeep road present since mid-century runs more or less *mauka/makai* just north of Hina Lani Street and is visible on the aerial view (see Figure 3). A bulldozer road, also visible on the aerial view, extends from Hina Lani Street north to the end of Huliko'a Drive.

Section 2 Methods

Historical documents, maps and existing archaeological information pertaining to the sites in the vicinity of this project were researched at the State Historic Preservation Division library, CSH Library, the University of Hawai'i's Hamilton Library, the Hawai'i State Archives, the State Land Survey Division, the Mission Houses Museum Library, the Hawai'i Public Library, the Archives of the Bishop Museum, and the Kona Historical Society. 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>)

The Office of Hawaiian Affairs, Hawai'i Island Burial Council, and members of other community organizations were contacted in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the study area and the surrounding vicinity. The names for potential community contacts were also provided by colleagues at CSH and from the researchers' familiarity of the families who frequent the area. Some of the prospective community contacts were not available to be interviewed as part of this project. A discussion of the consultation process can be found in Section 5 (Community Consultation Effort). Please refer to Table 2 for a complete list of individuals and organizations contacted.

2.1 Previous Cultural Impact Assessment

A CIA (Hammatt and Shideler 1996) was conducted for a portion of the project area in 1996 as a companion study to the Collin et al. (1996) study of TMK 7-3-009:017. Informants knowledgeable of the project area were interviewed. These consultations focused on identifying traditional cultural practices conducted within the project area as well as addressing community concerns regarding probable burial sites.

This summary of the CIA focuses on the probable burial sites located within that portion of the project area. The reader is referred to the CIA (Hammatt and Shideler 1996) for a detailed discussion and analysis of the traditional cultural practices documented within the project area.

On March 16, 1996, CSH staff interviewed the Reverend Norman Keanaaina, a *kama'āina* (native-born, one born in a place) of Kohanaiki since the 1940s. Reverend Keanaaina stated his belief that there were indeed burials within the TMK parcel 17 portion of the project area. He stated that interment within the TMK parcel 17 portion of the project area continued into the 1930s or 1940s, when his "grandmother's husband," the Kapaa family, was buried. Reverend Norman Keanaaina made a site visit with CSH personnel and was taken to three sites (SIHP No. -20702, -20717, and -20720) in the south central portion of TMK parcel 17, which had been previously identified by CSH as probable burials. The reverend agreed that the filled-in cracks at these sites were probable burials. He stated that the common practice was to wrap the body in a mat or a horse blanket, then inter it in a sufficiently large crack which would subsequently be filled with stones.

In 1996, eight possible burial sites (SIHP Nos. -20702, -20705, -20716, -20717, -20720, -20731, -20743, and -20749) had not been tested to determine the presence or absence of human skeletal remains, and testing was deferred to data recovery. Because the current CSH

archaeological inventory survey sought to re-evaluate and improve records for all of these sites, many of these sites were tested. The focus of this effort was to improve decision-making that now depends more heavily on findings of the archaeological inventory survey. The result of this testing was a reduction of eight possible burial sites to two probable burial sites. A third possible burial site (SIHP No. -20720) was determined to have been destroyed and is therefore no longer a current possible burial site.

Section 3 Traditional and Historic Background

3.1 Mythological and Traditional Accounts

3.1.1 Kekaha

The *ahupua'a* of Kohanaiki and Kaloko lie at the southern end of Kekaha, the portion of North Kona extending from Honokōhau to 'Anaeho'omalu. The character of Kekaha - as it had been established in the Hawaiian consciousness - is represented in a traditional saying recorded by Mary Kawena Pukui and in a brief description by John Papa 'Ī'ī. The saying, "*Kekaha wai 'ole na Kona*", translates to "waterless Kekaha of the Kona district." Pukui states that "Kekaha in Kona, Hawai'i, is known for its scarcity of water but is dearly loved by its inhabitants" (Pukui 1983:184).

Pukui (1983:271) also relates the importance of fishing in the following:

> *Ola aku la ka aina kaha, ua pua ka lehua I kai.*
>
> Life has come to the *kaha* lands for the *lehua* blooms are seen at sea.

Pukui (1983:271) further explains this saying: "Kaha lands refers to Kekaha. When the season for deep-sea fishing arrived, expert fishermen and their canoes headed for the ocean."

Samuel Kamakau, the native historian, relates that in the 15th century, High Chief 'Umi-a-Liloa fished for *aku* along the Kekaha coast, and around 1810, Kamehameha I also fished the shores of Kekaha (Kamakau 1961:20, 203).

Pukui et al. (1974:77-78) also relate that Kaloko is well known for the fishpond with the same name, and Kamehameha's bones are rumored to have been secretly buried here.

Kohanaiki means "small barrenness" (Pukui et al. 1974:115).

'Ī'ī describes the winds of Kekaha:

> ...a cold wind from Kekaha, the Hoolua. Because of the calm of that land, people often slept outside of [sic] the tapa drying sites at night. It is said to be a land that grows cold with a dew-laden breeze, but perhaps not so cold as in Hilo when the Alahonua blows. ('Ī'ī 1959:122)

These passages suggest that Kekaha was firmly identified with its austere physical environment. A legend told in Maguire (1966) reveals the importance of water resources in this general area (see also Wolforth 2005:8-9). The story takes place at the Cave of Mākālei, which is located outside of the current project area near 'Akahipu'u (a nearby mountain). The story focuses on a man named Ko'amokumokuohe'eia, who moved to this area and was told by the current residents that water was very scarce. Water, he was told, could be obtained in "celebrated" caves, but these caves were *kapu* (forbidden), and if caught, trespassers would be killed by the owner of the cave. However, Ko'amokumokuohe'eia discovered a very small cave entrance that no else knew about. The cave had water dripping from its roof (Maguire 1966:30). Ko'amokumokuohe'eia and his father used carved *'ōhi'a* and *wiliwili* trees to capture the dripping water, and his family was thus able to survive during dry spells. This legend clearly

demonstrates the importance of water as a resource that is difficult to procure, and it highlights the importance of water collection caves.

John Ka'elemakule Sr., a Kekaha native, wrote newspaper articles between 1928 and 1930 that provide details about life and customs in the last half of the nineteenth century. Kepā Maly (Maly and Maly 2003) translated these serial accounts that appeared in *Ka Hoku o Hawai'i*. The two following excerpts provide additional details related to water collection.

> ...There were not many water holes, and the water that accumulated from rain dried up quickly. Also there would be weeks in which no rain fell... The water which the people who lived in the uplands of Kekaha drank, was found in caves. There are many caves from which the people of the uplands got water... [September 17, 1929:3] (Maly and Maly 2003:42)

> ...The *kūpuna* had very strict *kapu* (restrictions) on these water caves. A woman who had her menstrual cycle could not enter the caves. The ancient people kept this as a sacred *kapu* from past generations. If a woman did not know that her time was coming and she entered the water cave, the water would die, that is, it would dry up. The water would stop dripping. This was a sign that the *kapu* of Kāne-of-the-water-of-life (Kaneikawaiola) had been desecrated. Through this, we learn that the ancient people of Kekaha believed that Kāne was the one who made the water drip from within the earth, even the water that entered the sea from the caves. This is what the ancient people of Kekaha wai 'ole believed, and there were people who were *kia'i* (guardians) who watched over and cleaned the caves, the house of Kāne... [September 24, 1929:3] (Maly and Maly 2003:42)

Kekaha was, however, "valued by ruling chiefs, inhabited by attendant chiefs, and upon occasion abused by warring chiefs" (Kamakau 1979:31). Describing the apportioning of land by the *ali'i* (royalty) before the ascendancy of Kamehameha, Kamakau records this information about the lands of Kekaha:

> Waimea [he is referring in this case to Waimea, O'ahu] was given to the Pa'ao kahuna class in perpetuity and was held by them up to the time of Kamehameha III when titles had to be obtained. But there was one land title held by the kahuna class for many years and that was Puuepa in Kohala. In the same way the land of Kekaha was held by the kahuna class of Ka-uahi and Nahulu. (Kamakau 1961:231)

Kamakau further records that during the 1770s, "Kekaha and the lands of that section" were held by descendants of the Nahulu line, the Ka-me'e-ia-moku and Ka-manawa, the twin half brothers of Ke'e-au-moku, the Hawai'i island chief (Kamakau 1961:310). The Great Seal of the State of Hawai'i depicts Kame'eiamoku and Kamanawa (Springer 1989:23).

Kamakau mentions Kaloko in an episode that suggests its significance within the pre-Contact Kekaha landscape. Kamakau recounts an extraordinary day's reconnaissance of the west coast of Hawai'i Island by the spy Ka-uhi-o-ka-lani, sent to the island by Kama-lala-walu, chief of Maui. Having reached Kawaihae by canoe at night, Ka-uhi-o-ka-lani "ran about that same evening [reaching as far south as Ka'awaloa] and returned before the canoes were dismantled..." Ka-uhi-o-ka-lani, describing his journey and the landmarks he observed, relates: "I went on to the long

stretch of sand, to the small bay with a point on that side and one on this side. There are large inland ponds." He is told that the "sandy stretch is 'Ohiki, and the walled-in ponds are Kaloko and Honokōhau" (Kamakau 1961:56). This event unfolds during the time of the sixteenth-century Hawai'i Island *ali'i* Lono-i-ka-makahiki, suggesting that by the 1500s, Kaloko and its fishpond were well-known features in the Kekaha landscape.

Intensive archaeological investigation during recent decades has clarified the picture of pre-Contact Hawaiian life within Kekaha and the two *ahupua'a* under study. An especially detailed study of Kaloko has resulted in the following analysis of the development of pre-Contact settlement throughout the *ahupua'a*:

> Throughout its span of occupation Kaloko was but part of a larger society. Kaloko was apparently a unified community after A.D. 1200-1300. When initially occupied (A.D. 1000-1500), it may have been an outlier of another community. Nevertheless, from its initial occupation, Kaloko had 1 or more internal local residence groups containing constituent households. By A.D. 1200-1300 at least 2 residential groups were present in the community, and by contact (circa A.D. 1778) at least 4 residential groups had dwelled in the area. Each residential group performed religious functions as well as being a leisure unit. Members of the group held use rights to adjacent farm lands and probably to areas where forest and marine resources were located. Within each residential group, 1 household seems to have been dominant, being the spatial focus for its group's religious activities. It is suggested that such dominance was a function of consanguineal seniority and/or wealth. (Cordy et al. 1993:45)

While exact population figures for Kaloko were not possible, the study suggested that the "community seems to have gradually grown in size but could never have been larger than 118 and most likely was about 60-100 in size" (Cordy et al. 1993:45). The general pattern of land use and settlement suggested for Kaloko may also have existed within the similar environment of neighboring Kohanaiki.

A detailed study of Kaloko by Cordy et al. (1991) for the National Parks Service has developed a model of pre-Contact settlement throughout the *ahupua'a*. The following is a summary of this model provided by the National Parks Service (2001):

> Permanent settlements in the leeward portions of Hawai'i Island began by the A.D. 900s to 1000s, and possibly earlier. These would have occurred near favorable water sources, Kaloko bay probably having been one of the most sheltered and inviting large inlets along the Kona Coast. Coastal habitations had expanded by the 1200s, utilizing inland fields as well as sea resources for subsistence. The Kekaha lands north of Kaloko and extending to Kohala are thought to have undergone initial permanent settlement beginning in the 1400s, with subsequent occupation of the coast north and south over the next few centuries.
>
> Sometime during the period of 1580 to 1600, Laeanuikaumanamana, the *kahuna-nui* of the ruling chief, Liloa, acquired the Kekaha region. It is thought that the construction of fishponds at Kaloko and Honokahau began during this time, with

Kaloko Fishpond dating from at least the 1400s to 1500s. During the 1600s to 1700s, as the Kona Coast population grew with the establishment of the royal residence of 'Umi-a-Liloa at Kona and the consequent increased demand for food production, Kaloko also increased to probably almost 200 residents. It continually supported a higher population than other Kekaha areas because of its fishpond and extensive inland field system. (National Parks Service 2001)

3.1.2 Kaloko Fishpond

Marion Kelly relates the legend of the *mo'o* or water spirit that resided in the Kaloko fishpond. The pond, as previously mentioned, dates to pre-Contact times.

> One informant explained that the pond was "Kupua" (spooky) and not like other ponds.
>
> Two informants declared that the pond at Kaloko was kapu and that there was a "Spirit" (Mo'o) of the pond which, if treated badly, would retaliate, bringing bad luck to those responsible, but if this spirit was properly cared for (malama) she would be cooperative.
>
> An illustration of how appropriate care was taken of the mo'o of Kaloko is provided by the story of Ahuna, a Chinese man married to a Hawaiian woman (Apa) and living at Kohana-Iki. Ahuna had leased the pond from Maguire (J.A. Maguire owned Hu'ehu'e Ranch and the project area lands), but before he removed any fish from the pond, he asked his friend Henry Ha'o to roast a suckling pig, specially prepared, which he took to the pond and laid on one of the two rocks which can still be seen today near the remains of the old net shed. By this act, it was explained, he fed (hanai) the mo'o of the pond and could thereby expect its assistance in obtaining a substantial number of fish from the pond. One informant said directly, "That's why he has good luck."
>
> Ahuna's daughter, Atati, married Henry Akona, and the house that stands today at Kohana-Iki, not far from the Kaloko-Kohana-Iki boundary, is sometimes identified as Akona's house, although he no longer owns it (Kelly 1971:27-28).

Another account of the fishpond was translated by Kepā Maly (1993:23) and relates part of the Legend of Ka-Miki (see below for additional information). Ka-Miki caught many *'anae* or mullet in the pond that he prepared and distributed to his family members. Ka-uluhe, his guardian, questioned the source of the fish.

> ...Ka-Miki described the pond, and Ka-uluhe told him that the 'anae were from the fishpond of the ali'i Ahauahale, his wife Pukaki, and his young brother 'Owela-a-Lu'ukia. Ka-uluhe asked, "How is it that they did not see you?" Ka-Miki told her that he only saw a stout bulging-eyed man sleeping along the pond edge. Ka-uluhe told him, "That man was Kumakapu'u, a guardian of the pond who controlled the abundance of the fish, and the restrictions of their use, as well as the use of the surrounding fresh water springs. Kumakapu'u is not a real man, but is a god who also cared for the offerings to the chiefess deities of the fishpond. The goddesses were 'O'opu-po'owai-nui-a-niho, Ka-lama-i-nu'u-nui-a-

> noho, and Kiha-wahine-iki-a-nanea; and they were the ali'i kapu Lono i'a (royal ones who kept the fish of Lono class restrictions).
>
> Kapakolea is the site which divides the pond, and was the halau ali'i (royal compound) of the gods. If the pond guardians were away from Kapakolea (traveling), the fish pond water would turn blood red, thus hiding the fish; and when the gods returned, the water would become greenish and the fish could be seen, and so these signs remain to this day. (Maly 1993:23)

3.1.3 The Legend of Ka-Miki

Kepā Maly (1993) translated the "Kaao Hooniua Puuwai no Ka-Miki" (The Heart stirring Story of Ka-Miki) that appeared in the newspaper *Ka Hoku o Hawai'i* between 1914 and 1917. The legend provides details about life and the environment of Kekaha as well as for the entire island of Hawai'i. Ka-Miki, the quick or adept one, and his brother Maka-'iole, rat or squinting eyes, traveled around the island to participate in competitions circa the thirteenth century when Pili-a-Ka'aiea was the chief of Kona. The boy's parents were Pōhaku-o-Kāne (male) and Kapa'ihilani (female), the *ali'i* of Kaloko and Kohanaiki. The legend relates that the supernatural brothers "were empowered by their ancestress Ka-uluhe-nui-hihi-kolo-i-uka (the great entangled growth of *uluhe* fern which spreads across the uplands), a reincarnate form of the earth-mother goddess, creative force of nature Haumea (also called Papa) who dwelt at Kalama'ula on Hualālai, in the uplands of Kohana-iki, Kona" (Maly 1993:21-22). The twins were raised by Ka-uluhe, who taught them how to use their supernatural powers.

Portions of the legend that are relevant to the current study follow. The following excerpt discusses the division of property within Ka-loko (the pond).

> The wood carved for the makaha (fish pond gates) came from 'Iwa'awa'a (near a halau ali'i [royal compound] and kahua [contest arena] of the chief Pohaku-o-Kane, on the plains of Kohana-iki next to Kaloko [1/15/1914]). The lands of Kaloko and Kohana-iki were jointly governed by Pohaku-o-Kane, though the ponds were under guardianship of other god-chiefs and chiefesses (5/21/1914).

Several of the stories identify *heiau* of Kaloko and Kohanaiki. The first appeared between April 16 and 30, 1914.

> The ocean at 'Ohiki was named Kauahia or Kai o Kauahia. After an 'awa ceremony with Ka-uluhe ma, Ka-Miki went to the shore of 'Ohiki to fish, in the pond waters of the chief Ahauhale. 'Ohiki was the name given for several places, including: a heiau; a cove; and an 'ili of Kaloko. The 'ili land parcel came to be known as Ki'ikahala after the punishment of the dual formed priest-shark Kalua'olapauila.
>
> On the night of Kāne the priests, chiefs, and people were observing the kapu of silence and all was being made ready to dedicate the royal compound of Ka'aipu'a at Kohanaiki. Ka-Miki and Maka-'iole descended to the coastal region of Kaloko and Kohanaiki from Kalam'ula and beat the drums in the heiau of Pohakea, 'Ohiki, Kaukeano, 'O'unui, Honu'iwa, Pu'uho'olelelupe, Kauki'eki'e, and Hale-o-Lono. The sound of the pahu heiau (temple drums) greatly startled the

> people, and caused the priests and chiefs of Kaloko to grumble amongst themselves. The sequence of events which followed, led to the naming of Hi'iakanoholae.
>
> A spring in the land parcel was also named 'Ohiki. The ocean of this area was named Kauahia before 'Ohiki came about, and following the death of the shark-priest Kalua'olapauila, the land section and temple of 'Ohiki came to be called Ki'ikahala.

The following appeared between January 8 and 15, 1914 and describes Hale-o-Lono, or house of Lono, a *heiau* in Kohanaiki where prayers for rain and abundant growth were offered.

> Hale-o-Lono was the husband of Pipipi'apo'o, a daughter of the deified beings Kumua and Ka-uluhe. Hale-o-Lono excelled at farming, and had the plain of Nanawale, Kohaha-iki well cultivated. His plantation was marked by Nahiahu, also called Nawahiahu (the alignment of cairns) on the makai side of this feature.

Additional information about Na'wahi'ahu was published between January 8 and 29, 1914:

> Na-wahi-ahu (the place [of] cairns) [or] Mahiahu is identified as a line of cairns which marked the agricultural fields of Hale-o-Lono, and the sacred plantation of Ka'aipu'a at Kohana-iki. Before Hale-o-Lono established his fields in this area this portion of Kohanaiki was called Nanawale (to look about – because of the extensive fields).

Details about why this area of Kohanaiki became important appeared between January 8 and May 28, 1914 and December 6, 1917.

> Ka-uluhe-nui-hihi-kolo-i-uka a reincarnate form of Haumea (also called Papa) lived at Kalama'ula in the uplands of Kohana-iki, below Hainoa. Ka-uluhe was the wife of Kumua, and the hill site at which Kumua dwelt is also called Kumua; it is below Kalama'ula, a little above the hidden spring of Kapa'ihi. The reason that Kumua lived at this hill was because it allowed him clear view of the coastal lands of Kohana-iki, which is where his children and grand children lived. One of the children of Kumua ma was Pipipi'apo'o and she was married to Hale-o-Lono (an agriculturalist and temple type, coastal Kohana-iki) who was an exceptional farmer. Hale-o-Lono excelled in his trade, and the place upon which he farmed was called Nanawale, and because he marked the area with many cairns, it came to be called Nahiahu, also called Nawaiahu, the place of cairns.

Nawahi ahu appears on Emerson's RM 1449 and RM 1512, dating to 1888 and 1889 respectively. A discussion of the maps and roads that appear on the maps is presented in the "Mid- to late -1800s" section below.

A more recent translation of the legend of Ka-Miki by Maly and Maly (2003:15) includes the following additional information about Nāwahiahu.

> Pipipi'apo'o was another daughter of Kūmua and Ka-uluhe-nui-hihi-kolo-i-uka. She married Haleolono, one who cultivated sweet potatoes upon the *'ilima* covered flat lands of Nānāwale, also called Nāhiahu (Nāwahiahu), as it has been called from before and up to the present time. Cultivating the land was the skill of

> this youth Haleolono, and because he was so good at it, he was able to marry the beauty, Pipipi'apo'o. Pipipi'apo'o skill was that of weaving pandanus mats, and there grow there many pandanus trees to this day. The grove of pandanus trees and a nearby cave, is called Pipipi'apo'o…

Maly (1993:28) notes that Hale-o-Lono, Ki'ikahala, and 'Ohiki are associated with sites and/or place names that are shared by Kaloko and Kohanaiki.

Ka-Miki completed his journey around the Big Island and

> …became the foremost champion of Pili (7/26/1917). It was at this time that Ka-Miki learned about the sacred palama chiefess Paehala of Honokohau; lands also called Na-Hono-i-na-Hau-'Elua (the bays of the two dews). Pili gave Ka-Miki permission to wed Paehala if she and her family agreed, and Pachala was the foremost beauty of Kona.
>
> When the chiefess agreed to marry Ka-Miki, Pili told Ka-Miki, that he would also, "oversee the chiefs' sacred fishponds [at Kaloko and Pa'aiea]; the schools of kala, uhu, and palani; and all the lands of Kekaha from Hikuhia which is above Napu'u u (also called Napu'upo'alu); and lands between Keahualono at Kaniku to the plain of Kanoenoe, marked by the hill of Pu'uokaloa at Keahuolu" (10/18/1917). (Maly 1993:22)

The following passage is from Kihe and appeared in *Ka Hoku o Hawai'i* between January 31 and April 10, 1928. It relates the variety of agricultural crops that grew in Kohanaiki and Kaloko:

> Departing from O'ahu, Makalie and his family landed at Hale 'uki, Ka'upulehu and were greeted by Ke'awalena a chief and overseer of the Kekaha region. Ka'upulehu and all Kekaha were extensively cultivated at this time. Dependent on seasons, the uplands were used for residences and farming, and the coastal lands fro residence and fishing. Pao wai (dug out water catchments) on the pahoehoe and in upland fields were a means of water catchment. Crops grown here included: taro, sweet potatoes, sugar canes, bananas, and 'awa…(Maly 1993:25)

Maly (1993:29) explains that traditional accounts of Kaloko and Kohanaiki describe a lush environment that differs from its current state due to several factors. The Hualālai lava flow in 1801 covered the former agricultural and forested lands, residential areas, and fishponds. The loss of forests began the decrease in rainfall that was exacerbated by the introduction of livestock and ranching. Goats and cattle stripped the vegetation from the lands causing water resources to dry up. Thus, over the last 150 years, the environment has been significantly altered.

3.1.4 The Pool of Wawaloli

Eliza Maguire (1966:11-17) collected and translated ten legends in 1923. Her husband, John Maguire, established Hu'ehu'e Ranch. *Paniolo* ("cowboys") working the ranch told the stories and Maguire decided they were too important to allow to fade away. "The Pool of Wawaloli" was near the coast "between Ooma and Kaloko." Although this legend takes place on the coast, it is the only one that Maguire translated that is within the vicinity of the current study area.

Malumaluiki, a beautiful maiden, leaves her parents' home to travel to the coast for shellfish and seaweed. On her way she becomes thirsty and stops to drink from a pool, where she meets a handsome young man. The two are immediately infatuated with each other and spend several hours together. Before Malumauiki departs, the handsome man tells her to call him Wawa when they are together, but call him Loli when she approaches the pool. He also teaches Malulmaluiki a chant to summon him at the pool.

After departing from her home several days in a row to meet Wawa, Malumaluiki's parents become suspicious since she never brings home any shellfish or seaweed. Her father follows her one morning and discovers that his daughter's lover has a human form and a sea-slug form. After observing the two together, he memorizes the chant to Loli and departs.

Malumaluiki's father consults with a *kahuna* (priest) to see how he can save his daughter. The *kahuna* tells him to trap and destroy Wawaloli which will save all the young women in the area from the lecherous evil wizard. The father returns to the pond, repeats the chant, captures Wawaloli with a net, and buries him in an *imu* (earth oven). Malumaluiki is sad to lose Wawaloli but much wiser. All that remains of Wawaloli is the pool he once occupied and still retains his name (Maguire 1926:21-26.)

3.1.5 Stillman Family Song

The following is a family song written by Rose Simerson about life on Hu'ehu'e Ranch. The song was sang by the Kahauanu Lake Trio, "Ke Po'okela", Volume II Album. The Stillman family descends from Kipikane, the great granddaughter of Kamehameha I, who married John P. Parker, the founder of Parker Ranch (Kanoa-Martin 2007). This is their family song:

Keiki mai au no Hu'ehu'e 'eā 'eā	*I learned to throw a lasso and crack the whip*
Kīpuka 'ili a'o kani ka uwepa	*From childhood at Hu'ehu'e*
Ka waiho laulā ka'u aloha 'eā 'eā	*The broad open plains I love*
Ku'u lio puakea ha'a i ke kula	*My white horse goes prancing in the high pasture land*
Maika'i Hu'ehu'e e waiho nei 'eā 'eā	*Hu'ehu'e is a fine place, lying there below*
Ho'okahi no hewa he ulua 'ole	*Too bad there's not even one fish (cowboy)*
Ua ho'i ka ulua i Kahalu'u 'eā 'eā	*The cowboys went to Kahulu'u town*
I ke ani peahi lau o ka niu	*Where the palm leaves beckon*
A komo i ka malu lau kukui 'eā 'eā	*In the kukui leaf shade*
Ho'ola'i nā iwa oia uka	*The birds of the upland are made still*
Ha'ina 'ia mai ana ka puana 'eā 'eā	*The story is told*
Kipuka ili a'o kani ka uwepa	*Of learning to throw a lasso and crack the whip*

3.2 Early Historic Period

Kamakau (1961) reports that during the war between Alapa'inui of Hawai'i and Kekaulike of Maui, Kekaulike "abused the country people of Kekaha" by destroying all the coconut groves and slaughtering "the country people." The destruction of these valuable trees was devastating.

As previously mentioned, Kekaha lands were set aside for the priestly class:

> Waimea [O'ahu] was given to the Paao Kahuna class in perpetuity and was held by them up to the time of Kamehameha II when titles had to be obtained. But there was one land title held by the kahuna class of Paao for many years and that was Puuepa in Kohala. In the same way the land of Kekaha was held by the kahuna class of Ka-uahi and Nahulu. (Kamakau 1961:231)

During the last decades of the eighteenth century, following western contact, Kohanaiki and Kaloko - as elements of the larger Kekaha area - remained under the control of Ka-me'e-ia-moku, who resided to the north at Ka'upūlēhu (Kamakau 1961:147). Ka-me'e-ia-moku's son, Ulumaheihei Hoapili, "belonged to the priesthood of Nahulu and was an expert in priestly knowledge. He had been taught astronomy and all the ancient lore" (Kamakau 1961:354).

Archibald Menzies, the first foreigner to record his visit to Kekaha, accompanied Captain Vancouver in 1792. He described the land as "barren and rugged with volcanic dregs and fragments of black lava…in consequence of which the inhabitants were obliged to have recourse to fishing for their sustenance" (Menzies 1920:99).

On January 17, 1792, Menzies hiked to the top of Hualālai, and observed the following:

> We commenced our march with a slow pace, exposed to the scorching heat of the meridian sun, over a dreary barren track of a gradual ascent, consisting of little else than rugged porous lava and volcanic dregs, for about three miles, when we entered the bread fruit plantations whose spreading trees with beautiful foliage were scattered about that distance from the shore along the side of the mountain as far as we could see on both sides. Here the country began to assume a pleasant and fertile appearance through which we continued our ascent for about two miles further, surrounded by plantations of the esculent roots and vegetables of the country, industriously cultivated…From this place we had a delightful view of the scattered villages and shore underneath us, and of the luxuriant plantations around us…
>
> January 18th….We observed here and there on the path little maraes [shrines] pointed out by taboo sticks in the ground round a bush or under a tree. In passing these places the natives always muttered a prayer or hymn, and made some offering as they said, to their akua, by leaving them a little piece of fruit, vegetable or something or other at these consecrated spots. Even in this distant solitary hut, we found a corner of it consecrated by one of these taboo sticks which the natives earnestly requested us not to remove when we took possession of it, and we very strictly obeyed their injunction, conceiving that religious forms whatever they are, ought to be equally inviolable everywhere. (Menzies 1920:151-160)

Kamakau recorded that Kaloko is the site where Kamehameha's bones were cached by Hoapili after the king's death in 1819:

> Kamehameha had...entrusted his bones to Ulu-maheihei Hoa-pili with instructions to put them in a place which would never be pointed out to anyone. At midnight, therefore, when black darkness had fallen and no one was likely to be on the road and the rough lava plains of Pu'ukaloa lay hushed, Hoa-pili sent his man, Ho'olulu, to bring the container of wicker work in which the bones of Kamehameha were kept to Kaloko in Kekaha...The next morning Hoa-pili and Ke-opu-lani took canoe to Kaloko where Hoa-pili met the man who had charge of the secret cave and together they placed the bones there. (Kamakau 1961:215)

Kelly (1971:25) notes a February 16, 1887 letter to a person named Kapalu as the "overseer and keeper of the Royal Burial Ground at Kaloko, Kailua." The Interior Department of the Hawaiian Kingdom provided Kapalu with a $20 a month stipend, for seven months. A second letter reappoints Kapalu as a caretaker although there is no payment for his services. Kelly also relates that an informant's grandfather had disclosed the location of the burial cave, and he would move the remains to protect them. Another informant stated that women are not buried at Kaloko, only men of high rank. Other informants revealed that the burial caves were inland and not in the vicinity of Kaloko Pond (Kelly 1971:25).

Kamakau's account regarding the caching of Kamehameha's remains suggests that Kaloko's population, toward the end of the nineteenth century's second decade, had diminished to such an extent that the *ahupua'a* could provide the necessary isolation and secrecy for the burial.

By the early nineteenth century, the inhabitants of Kaloko and Kohanaiki had long experienced the social pressures and consequences of western contact. "As early as 1788, Hawaiians began enlisting as seamen on the foreign ships that stopped at Island ports, and their number increased rapidly with the growth of whaling in the Pacific" (Schmitt 1973:16). As harbor facilities were developed at Kailua and Kealakekua during the early 1800s, these ports became population centers drawn from increasingly isolated (economically and socially) areas like Kaloko and Kohanaiki. Newly-introduced diseases cut the population severely.

Missionary censuses of the 1830s chart the diminishing population of Kekaha and North Kona. In 1834, the total population of Kekaha is recorded as 1,244, comprising 21% of the total North Kona population of 5,957 (Schmitt 1973:31). The North Kona figure represents a population loss of 692 since the previous census of 1831 (during which no figure specific to Kekaha was noted), which recorded 6,649 persons in the district (Schmitt 1973:9). One factor - inter-island migration – which led to the diminishing population of Kona was specifically noted by missionaries in 1832: "We have been sensible for some time that the number of inhabitants in this island is on the decrease. There is an almost constant moving of the people to the leeward islands, especially since the removal of the governor (*Kuakini*) to Oahu. Some leave by order of the chiefs, and others go on their own responsibility" (cited in Schmitt 1973:16).

Land Commission documents of the 1840s and 1850s record the disposition of population and land use within Kohanaiki and Kaloko *ahupua'a* that had evolved since western contact. At the Māhele of 1848, Kaloko was claimed by and awarded [Land Commission Award (LCA) 7715] to Lot Kamehameha (who would become Kamehameha V). Kohanaiki was classified as

Government Land. Subsequently, 18 *kuleana* claims - by commoners claiming to occupy and/or cultivate land parcels - were made in Kaloko. Twelve of these claims were awarded. All claims were for *mauka* lands - between 1200 and 1700 ft. elevation - adjacent to or just *makai* of the Government Road. Only testimony for Kahiona's (unawarded) claim (LCA 9205/9237) mentions a fishpond; no claims were made for the coastal area. Farm lands claimed are *mala*, *kihapai*, and *mo'o*, i.e. forms of dry land agriculture; actual crops identified in the award testimonies are taro and sweet potato. Only five of the total 18 claims mention residence on or use of the Kaloko lands dating to the time of Kamehameha I, the first decades of the nineteenth century; the remaining claims testify to residence/use beginning in the 1830s and 1840s.

Parcels within Kohanaiki, having become Government Land, were subject to sale - designated grants - by the Hawaiian Kingdom government. Land sales began in the 1850s with Grant 2030 to Kaiakoili in 1856, awarding 102 acres adjacent to and *makai* of the Government Road. Also beginning in the 1850s, the first taxpayer rolls for Kohanaiki and Kaloko were documented: they indicate, within Kohanaiki, eight, 13 and 12 taxpayers during the years 1857, 1859 and 1860, respectively; within Kaloko, during the same years, 19, 21 and 23 taxpayers were recorded. Just past the middle of the nineteenth century, the populations of Kaloko and Kohanaiki had been drawn beyond the original subsistence-based economy into the western commercial paradigm.

As Cordy notes about Kaloko: "The historical documents suggest that by the 1840s-1850s, the Coastal Zone had been abandoned as a residential area, except probably for a house used by the fishpond's caretaker. This pattern would have been a stunning change from prehistoric and early historic times, when many coastal residences were present" (Cordy et al. 1991:288). This pattern likely also held for Kohanaiki.

3.2.1 Cultivation

Despite descriptions of the lava covered terrain, various crops were traditionally cultivated within the project area, and sweet potato is likely to have been the most abundantly grown crop because of its adaptability to stony, dry environments. It was commonly planted in mounds and in *pāhoehoe* excavations.

Henry J. Lyman, son of missionaries that first arrived in Hilo in 1831, describes features in Puna similar to *pāhoehoe* clearings in the project that were cultivated with sweet potatoes:

> Whereever the lava could be pounded into scoria, a plantation of sweet potatoes was laboriously formed by digging among the stones and filling in the holes with dried grass brought from the mountainside. Placed in the nest, the tuberous buds were covered with gravel, and there grew with astonishing luxuriance, yielding the largest and finest potatoes on the island (in Frierson 1991:167).

During the mid 1800s, Captain Charles Wilkes of the American Exploring Team comments on the agricultural use of *pāhoehoe* excavations (similar to the modification of *pāhoehoe* outcrop in the project) which he observed specifically in the Kona region:

> Cultivation is carried on in many places where it would be deemed almost impractible in any other country. The natives, during the rainy season, also plant, in excavations among the lava rocks, sweet potatoes, melons, and pine-apples, all of which produce a crop. (Wilkes 1845:91)

Sweet potatoes were also cultivated within walled fields or depressions in the walls themselves. E.S. Craighill Handy and Elizabeth Green Handy discuss this method from an account that appeared in the Hawaiian newspaper *Ka Nupepa Ku'oko'a* (March 24, 1922):

> Rocky lands in the olden days were walled up all around with the big and small stones of the patch until there was a wall (*kuaiwi*) about 2 feet high and in the enclosure were put weeds of every kind, *'ama'u* tree ferns and so on, and then topped well with soil taken from the patch itself, to enrich ti, or in other words to rot the rubbish and weeds to make soil.
>
> After several months, the rotted weeds were converted into soil of the best grade. The farmer waited for the time when he knew that the rains would fall, then he made the patch ready for planting. If for sweet potatoes, he made mounds for them and for taro too, on some places on Hawai'i. (Handy and Handy 1972:131)

3.2.2 Ranching

Ranching has its roots in this early historic period with the introduction of goats, cattle, and horses by sea captains who sought to develop these resources to replenish their ship holds during long journeys. Captain George Vancouver gave Ke'eaumoku, an *ali'i*, a pair of goats in 1792, and the following year, he brought Ke'eaumoku four sheep. Vancouver also brought the first cattle, California longhorns, to Kamehameha I in 1793. Kamehameha issued a *kapu* (in this case, a prohibition) that carried the death penalty to anyone harming cows or cattle thus ensuring that the first herds would proliferate. The *kapu* was enforced for 10 years. Due to the *kapu*, families constructed walls to protect their sweet potato and taro lands from the cattle. Kamehameha ordered the construction of a wall, *mauka* of the project area, that ran from north to south Kona, to prevent cattle from destroying populated areas (Bergen 2004:22-23). Historical research suggests that both goat and cattle grazing took place within the project area.

In 1803, horses were introduced, and they also ran free although no *kapu* protected them. Horses had difficulties acclimating to local grasses, and herds of feral horses were rare until the 1830s. At that time, Kamehameha III had California *vaqueros*, cowboys of Native Californian, Spanish, and Mexican descent, brought to Hawai'i to herd the cattle and teach Hawaiians to ride horses and tend the cattle. The *paniolo*, as they were called, were expert horsemen and able to chase down the wild cattle on horseback and capture them with a lasso. The hide and tallow trade proved to be successful and cattle were shipped from Kailua Bay to slaughterhouses on O'ahu (Figure 5 and Figure 6). In 1851, it was estimated that Hawai'i Island had 8,000 head of tame cattle and 12,000 head of wild cattle (Kelly 1983:79; Bergen 2004:23, 97).

Historic documents related to the Government Homestead Program of the late 1880s indicate officials determined that goats were the only animals that were adept at grazing within arid, rocky Kaloko and Kohanaiki (Maly and Maly 2003:76, 79). Goats were present in the area prior to the late 1880s and may have been present within the project area. Limited cattle ranching was practiced at the same time, although by 1900, cattle ranching had for the most part replaced the goats (Maly and Maly 2003:75).

Figure 5. Kailua Wharf on Steamer Day, circa 1890, Moku'aikaua Church in background (photograph by R. J. Baker)

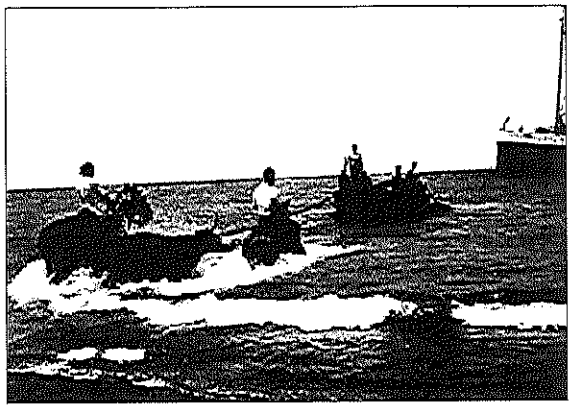

Figure 6. Loading cattle on the Kona Coast, Hawai'i (Faris 1929:296)

3.3 Mid- to Late -1800s

The division of Kohanaiki - through sales of Government lands -continued throughout the remainder of the nineteenth and into the twentieth century. Grant 2942 in 1864 awarded to Huliko'a 929.75 acres which included the width of the *ahupua'a*, extending *makai* from Kaiakoili's grant. In 1871, Grant 3086 awarded 154 acres to Kapena; this parcel extended *makai* from Huliko'a's grant to the shoreline.

At the time of the Māhele, Huliko'a was a resident of Kohanaiki (Maly and Maly 2003:4). Although Maly and Maly (2003:60) reviewed all Māhele claims, no additional references to Huliko'a were found. However, based on traditional patterns of residency in the region, it is "likely they had primary residences in the uplands, near sheltered *māla 'ai* (agricultural fields), and kept near shore residences for seasonal fishing, collection of salt, access to water in dry periods, and for access to other resources of the coastal zone" (Maly and Maly 2003:60). Maly and Maly (2003:66) also note that during their research "the original notes of survey and map accompanying Grants 2030 and 2942, are missing from the state collection, so the corresponding maps and surveys, and their relationship to Kapena's parcel could not be compared with the original records." These survey documents were also not found during the current study.

Kaloko is documented during the 1870s in testimonies by Hawaiians before the government's Boundary Commission. Testifying on August 12, 1873, Nahuina (who had earlier received LCA 10327 in Kaloko) describes himself as "born at Kaloko North Kona Hawai'i at the time of Keikepuipui, the building of the *heiau* at Kailua, and have always lived there" and states that the boundaries of Kaloko were shown to him by his father, the former *konohiki* of the *ahupua'a*. Identifying the mauka portions of the boundary, Nahuina notes bounds defined by vegetation and a wall (iwi aina), and recalls a former habitation site:

> ...From the makai side of Kaupulehu the boundary runs along said land, the koa being on Kaloko and the mamani and pukeawe [sic] on Kaupulehu to the corner of Lanihau 2nd Keahuolu and Honokohaunui...Ohiawela, a *pali*, on the road through the woods is a point on the boundary. This place is above Honokohaunui, thence turn makai to Kahua, a place in the fern where houses used to stand, from thence the boundary runs makai along an *iwi aina* to Kapokalani, at the Government road. Thence makai still following the *iwi aina* to Kiikii an ili aina, thence to Kaohe, a grove of trees thence to *aa*...

Nahuina adds that Kaloko has "ancient fishing rights extending out to sea." Testifying on the same date, Hoohia, who "moved to Honokohauiki when quite small and reside[s] there now", adds details that suggest the *mauka* Kaloko-Honokōhau boundary was defined by different vegetation that also reflected former traditional gathering rights: "Honokohaunui ends at Ohiawela, a *pali*. Kaloko takes the *koa*, and Honokohaunui, the *ohia*...The *olona* grows on Honokohaunui and Kealakehe and the *koa* on Kaloko."

During the 1880s, Kona lands - including Kaloko and Kohanaiki - were surveyed by J.S. Emerson for the Hawaiian government. A portion of his Registered Map (RM) 1449, Akapipu'u Section (Figure 7) shows a trail through the project area; the trail actually ran from the Kohanaiki Homesteads to the Kaloko fishpond. Emerson produced three maps corresponding to the project area during this time period: Registered Map (RM) 1280, RM 1449, and RM 1512. Emerson's

assistant, J. Perryman also produced sketches of the west slopes of Hualālai. Although other surveyors and historians have produced maps for the area, these maps are the most comprehensive. RM 1280 (Figure 8) is cited and reproduced with the most frequency. It is often dated to 1888, but the map does not indicate an original date; rather, the date the map was traced by another surveyor in 1952 for reproduction purposes. An independent attempt to verify its date during the present study was unsuccessful, as the original map is now retired and not available from the State Survey office. Circumstantial evidence dating the map includes the sketches of J. Perryman dated to 1882 that match the features of this map and a date range penciled on the back of the traced map on file - "1877-1903." RM 1449 and RM 1512, dating to 1888 and 1889 respectively, are essentially maps of the same series. RM 1449 is a broad overview map ranging from Kaloko to Kūki'o in the north, and RM 1512 is a detail of the land grants around the government road.

A portion of RM 1280 shows the locations of the three large Kohanaiki grants discussed earlier. Also indicated are "Kealiihelepa Hse" at the coast above the Kaloko fish pond and, near the government roads, "Kaloko Cath. Church" and "Kohanaiki Church," which is likely the Protestant church recorded as built by a minister, Kaanohimaka, and his congregation in the 1870s (Kelly 1971:14). As noted by Cordy et al. (1991:418), Emerson's map of the area including the Kohanaiki Church indicates "a set of about 16 stone house enclosures and a Protestant church, collectively called the Kohanaiki Homesteads;" Cordy et al. suggest a "late 1880s age for the formation of the Kohanaiki Homesteads." Kelly (1971) notes that the Kohanaiki Homesteads would draw people as other areas of North Kona were abandoned. Government records of Kohanaiki grants show 18 parcels ranging in size from 0.73 acres to 25.45 acres awarded between 1895 and 1904.

A composite of RM 1449 and RM 1512 (see Figure 7) shows an alternative view of both the country side and the detail in the area of the Kohanaiki Homesteads. Most visible are family claims in the Kohanaiki Homesteads and Kohanaiki Road running directly *makai* from the homesteads. The road ends abruptly on RM 1449, although it appears to come close to joining the prominent "Lower Government Road." The indication of the "Lower Government Road" also ends shortly into Kaloko.

While all three Emerson maps provide survey information for the area, there are inconsistencies that are difficult to interpret. All were surveyed within a short time period but RM 1280 does not indicate survey stations as the others do. The largest inconsistency is the route of the two roads extending *makai* from the homesteads – on RM 1280 crossing into Kaloko just outside of the homesteads and on RM 1449 crossing upslope of the project area. Since RM 1280 does not give a name to this road and the date of the map is somewhat uncertain, it is possible that there were two roads, one superseding the other. It is also likely that RM 1280 was simply a preliminary survey (if the dates for J. Perryman's sketches date the map) and was less accurate (since it did not use many survey markers).

Oral history interviews (Maly and Maly 2002) relate that in the mid-1800s only a few residences were on the coastal lands, in the uplands above 900 ft. elevation, and in the vicinity of Māmalahoa Highway (east of the project area). The land between 900 ft. and the coast was cattle, donkey, and goat pasturage. *Mauka/makai* trails through Kohanaiki, Kaloko, Kalaoa, and

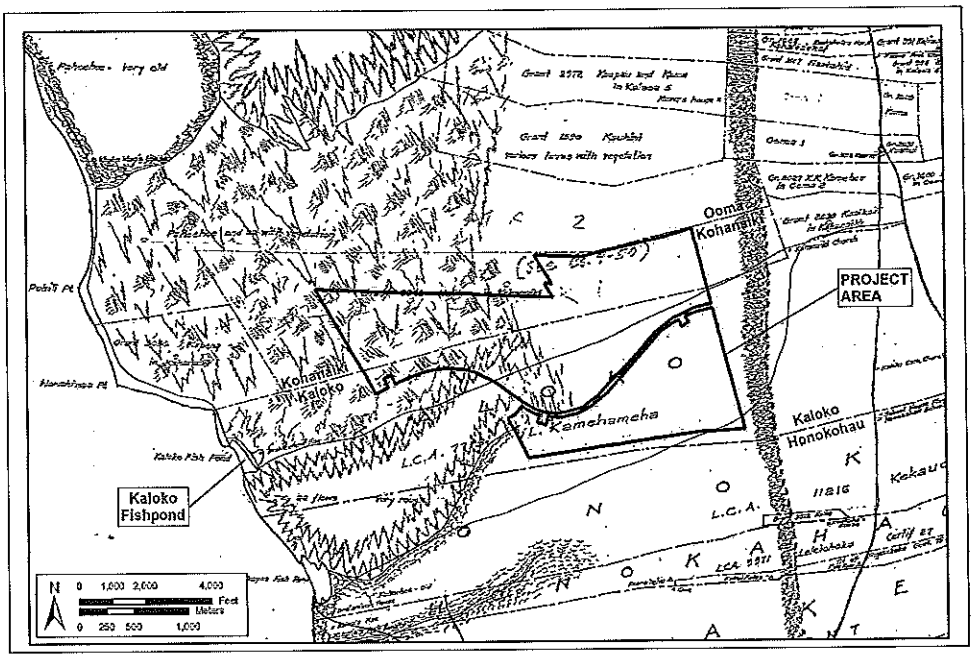

Figure 8. Portion of Registered Map 1280 by J. S. Emerson showing location of project area

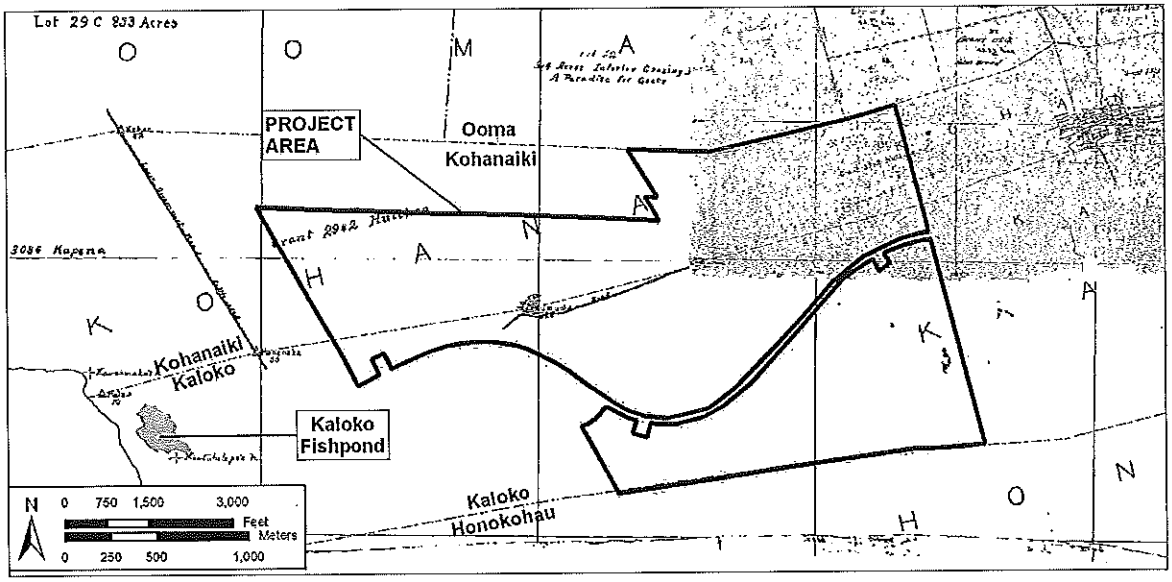

Figure 7. Portions of Emerson's RM 1449 (1888) and RM 1512 (1889) showing the road from Kohanaiki Homesteads

Honokōhau were utilized by upland families to access the coast to fish, and gather water during upland droughts.

Kaloko and most of Kohanaiki continued to be held by the *ali'i* throughout the remainder of the nineteenth century, passing, after the death of Lot Kamehameha, successively to Bernice Pauahi Bishop, Kalākaua and Kapi'olani.

Maly and Maly (2002:339) translated the following 1875 letter to the editor of *Ku Okoa*, the Hawaiian newspaper. The letter was written in response to another letter describing a drought in the Kekaha region and the subsequent famine. J.P. Pu'uokupa, the writer, lived in Kekaha:

> ...The people who live in the area around Kailua are not bothered by the famine. They all have food. There are sweet potatoes and taro. These are the foods of these lands. There are at this time, breadfruit bearing fruit at Honokohau on the side of Kailua, and at Kaloko, Kohanaiki, Ooma and the Kalaoas where lives J.P. [the author]. All of these lands are cultivated. There is land on which coffee is cultivated, where taro and sweet potatoes are cultivated, and land livestock is raised. All of us living from Kailua to Kalaoa are not in a famine, there is nothing we lack for the well being of our bodies. Mokuola (reference to a small island in Hilo Bay that is a sanctuary, and place of life and healing – indicates Kekaha is also) is seen clearly upon the ocean, like the featherless back of the ukeke (shore bird). So it is in the uplands where one may wander gathering what is needed, as far as Kiholo which opens like the mouth of a long house into the wind. It is there that the bow of the boats may safely land upon the shore. The livelihood of the people there is fishing and the raising of livestock. The people in the uplands of Napuu are farmers, and as is the custom of those people of the backlands, they all eat in the morning and then go to work. So it is with all of the native people of these lands, they are a people that are well off...
>
> ...As was said earlier, coffee is the plant of value on this land, and so is the raising of livestock. From the payments for those products, the people are well off and they have built wooden houses. If you come here you shall see that it is true. Fish are also something which benefits the people. The people who make the pai ai on Maui bring it to Kona and trade it. Some people also trade their poi for the coffee of the natives here... (J.P. Puuokupa, in Ku Okoa November 27, 1875; translated by Maly)

The following is excerpted from George Bowser's (1880) "Directory and Tourists Guide." Bowser traveled around the Hawaiian Islands and published his guide detailing places of interest. His observations during his journey along the west coast of the Big Island include:

> ...From Kiholo the road southwards is rough and laborious. Perpetual traveling over lava is very hard upon our horses, and it is impossible to travel faster than the slowest walk... Some twelve miles from Kiholo we began to cross the western shoulder of Mauna Hualālai, and the aspect of things changed, although the condition of the road did not. Here all around, for miles and miles, trees are growing thickly, on the otherwise almost bare surface of the lava. In numberless instances these trees, which are numerous enough in places to form a dense forest,

> grow out of lava pure and simple, without a semblance of soil of any kind to support them... Pursuing my way through this forest land, I enjoyed, in spite of the roughness of the road, one of the most delightful days experienced throughout my journey.... In this woodland I heard for the first time since I landed on the islands the notes of a pretty little bird about the size of a lark, called by the natives akakane. Its song is very sweet; nor is it the only songster of the woods. One especially I noticed, called iiwi, from its note. During the ride we saw numbers of native geese and sundry herds of goats skipping from ledge to ledge on the lava beds. Presently I reached the ridge of the mountain and had a fine view of the surrounding country...
>
> Fronting the sea...in North Kona there is a rich tract of bottom land which might be turned to good account. Large areas of the mountain land might also be cultivated for coffee...I was astonished to see in this district how bananas, mangoes, oranges, pineapples, in short all the fruits belonging to these islands, grow in profusion...
>
> At Kohanaike, a place about six miles short of my destination, I came upon a store kept by a Chinaman, who has Hawaiianized his name to Akao. Here the tourist, if he has no supplies with him, can get anything he wants, in the way of canned fish, milk, crackers, etc., and if night should overtake him here, a bed can always be had. I finished my day's journey at Kailua, passing on the way a small place called Kaloko, where there is a blacksmith shop kept by Mr. Philip Ryan...(Bowser 1880:547-549)

Bowser also included the following individuals as residents of Kohanaiki or Kaloko in 1880:

> Kaiakoili lived in Kohanaiki and was a coffee planter who owned 600 acres, 10 of which were cultivated (Bowser 1880:215, 339).
>
> Katy Ryan lived in Kaloko on Kailua Road and was also a coffee planter and owner with seven cultivated acres (Bowser 1880:262, 349).

3.4 1900s

During the twentieth century, major developments focused on Kaloko Ahupua'a, with continuing commercial use of the fishpond and increasing animal husbandry. The Kohanaiki Homesteads were apparently in decline during the early part of the century (Maly and Maly 2003), and are mentioned only in passing in H.W. Kinney's 1913 guide to the Big Island, which notes that it is an "inland settlement without much interest." However, "from Hu'ehu'e southward the road passes through fertile lands, dotted with prosperous homes of Hawaiians, and some Japanese, planters of coffee and other crops (Kinney 1913:53). It appears that lands closer to the coast were inhabited. It should also be noted that Hu'ehu'e likely refers to the town Hu'ehu'e and not the ranch that extended into the project area.

Ranching steadily increased. Once John Maguire purchased the former chiefly lands of Kaloko in 1906 after the deaths of Kalākaua and Kapi'olani (Kelly 1971:29), the *ahupua'a* uplands were developed into the Hu'ehu'e Ranch. Maly and Maly (2003) discuss the acquisition of these lands and the types of ranching that were common:

> In 1899, John A. Maguire, founder of Hu'ehu'e Ranch applied for a Patent Grant on... lots in 'O'oma 2nd, but he only secured Grant No. 4536.... Maguire's Hu'ehu'e Ranch did secure General Lease No.'s 1001 and 590 for grazing purposes on the remaining government lands in the Kohanaiki and 'O'oma vicinity. Thus, by the turn of the century, Hu'ehu'e Ranch, utilized both the upper forest lands and lower kula lands to the shore for ranching purposes. Oral history interviews with elder former ranch hands record that this use extended across the Kapena and Huliko'a grant lands of Kohanaiki, from the fee and leasehold lands of Kaloko and 'O'oma. Nineteenth century goat drives gave way to formalized cattle drives and round ups on these lands. (Maly and Maly 2003:78)

3.5 Hu'ehu'e Ranch

John Avery Maguire was the son of Charles and Hiilawe Maguire. He was born in Hamakua, Hawai'i in 1848 and began his ranching career as a foreman for the Pu'uhue Ranch. Maguire later became the ranch manager and then purchased Hu'ehu'e Ranch in 1888. His biography indicates that he did not live at the ranch until 1897, but this is contradicted by other sources, as is the date of purchase. He also bought Kahuā Ranch Company in 1890 and sold it in 1898 to J.F. Woods (Siddall 1917).

John Maguire and his first wife, Luka Hopula'au, had one child, Charles Ka-ulu-hei-malama Maguire, before Luka died in 1898. Maguire inherited his wife's lands in Kona that included Grants 926 and 2121 in Puaa and Kuki'o that were previously owned by Pupule (Kelly 1971:44-46).

Kelly (1971:41) notes that in 1914, J.A. Maguire leased the Kaloko fishpond for 15 years to the Mokuaiai fishing *hui* (group or collective), indicating that he owned the lands. Additionally, Kelly's research of manuscripts at the Bishop Museum includes a document by Lono Maguire on medical lore. This Maguire was identified as a *kahuna lapa'au*, or medicinal expert. Kelly (1971:41) was unable to determine if Lono and John A. Maguire were related.

According to Kelly (1971), the 1918 Polk Directory (p. 960) lists Mrs. John A. Maguire as the commissioner of public instruction for North Kona. Her husband is listed as the President of John A. Maguire Estate, Ltd., and manager of Hu'ehu'e Cattle Ranch at Hu'ehu'e, North Kona. This "Mrs. Maguire" was John Maguire's second wife, Eliza. She recorded some of the traditional accounts of tales she heard on the ranch; "The Pool of Wawaloli" was one of the legends she translated and it appears above in the Mythological and Traditional Accounts section.

Likely due to its location north of the most populated area on the Big Island, Hu'ehu'e Ranch received many guests over the years including Queen Lili'uokalani, Prince Jonah Kuhio Kalanianaole, Sanford Dole, first president of the Republic of Hawai'i, and Jack and Charmian London (HawaiiHistory.org 2008).

John A. Maguire's lands extended well beyond the current project area to the north into Waipi'o Valley according to research conducted by Lebo et al. (1999). Maguire, his wife Eliza and his son Charles, conducted multiple land transactions within Waipi'o Valley between 1898 and 1915.

The following information is from the Kona Historical Society's Archive, Hu'ehu'e Ranch Records for 1958-1987. Thelma Springer, the great-granddaughter of J. A. Maguire, and her husband, Philip Springer, and Carl A. Carlson, Jr., the ranch manager for many years until his recent retirement, provided the historical society with the information.

By the time J.A. Maguire died in 1919, Hu'ehu'e consisted of 40,000 acres of land, most of which was leased from the Bishop Estate. He owned 2,500 head of cattle and 500 sheep. His son, Charles, and daughter-in-law Mary Kiha-lani-nui, pre-deceased him, and their only child Aileen Ruth Kiha-lani Maguire lived with her grandfather and inherited Hu'ehu'e Ranch.

Aileen married Arthur Joseph Stillman at the St. John the Baptist Chapel in Kohanaiki on December 27, 1917. Stillman became the ranch's general manager following the death of his father-in-law in 1919. The couple had four children including:

> Thelma Kiha-lani who latter married Philip P. Springer. Their daughter is Hannah Kiha-lani Springer;
>
> Ruth Ka-papa-ku'i-ali'i, who died in infancy;
>
> Mary Ka-haili-o'pua, who later married James Allen Robinson. Their daughter is Aileen Ruth Robinson;
>
> Nancy Ka-hiwahiwa, who later married Carol A. Oliver. Their children are Carole, Richard, Myra, John Avery, and Luka.

The Maguire/Stillman family held thousands of acres of property on Hawai'i including lands outside of the project area that are part of Hu'ehu'e Ranch. Maguire initially leased lands from the Bishop Estate and inherited lands from his first wife, as mentioned above; he later added acreage acquired from Kapi'olani at Kaloko.

A livestock survey conducted by the University of Hawai'i in 1927 states that the total land holdings at the time were 40,000 acres, 25,000 acres were leased and the remaining 15,000 was owned fee simple. Hu'ehu'e was south of Pu'uwa'awa'a Ranch and extended from sea level to 1,600 ft. elevation.

Only 12,000 acres were suitable for grazing, since large areas were covered with lava flows, and dense vegetation including lantana and ferns. Hu'ehu'e Ranch contained some 2,000 grade Herefords, 20 purebred Hereford bulls, and 20 purebred cows. Annually, approximately 330 to 400 head of cattle was sold, loaded on steamers in Kailua-Kona, and shipped to Honolulu (University of Hawai'i 1927:28).

There are "seven miles of pipe line which lead from tanks near a natural spring to various parts of the ranch."Additionally, the ranch "is fairly well supplied with fences and paddocks (University of Hawai'i 1927:28).

The Maguire/Stillman family held Hu'ehu'e Ranch until they sold it on July 8, 1966. At that time, the Kona Coast Company, a partnership between the Kaloko Land Corporation, Mauna Loa Cattle Corporation (which later was separately held by members of the Karl B. Rodi family), and Foothill Land Corporation (which was later succeeded by the David Pacific Corporation and Davis family members) was established. The company owned and operated the ranch that was

managed by Roger T. Williams. In early 1970, Carl Carlson became the general manager, and as mentioned above, recently retired.

Kona Historical Society records indicate that cattle ranching continued on Hu'ehu'e Ranch although game bird hunting and residential and resort development of properties became more important business aspects (Figure 9).

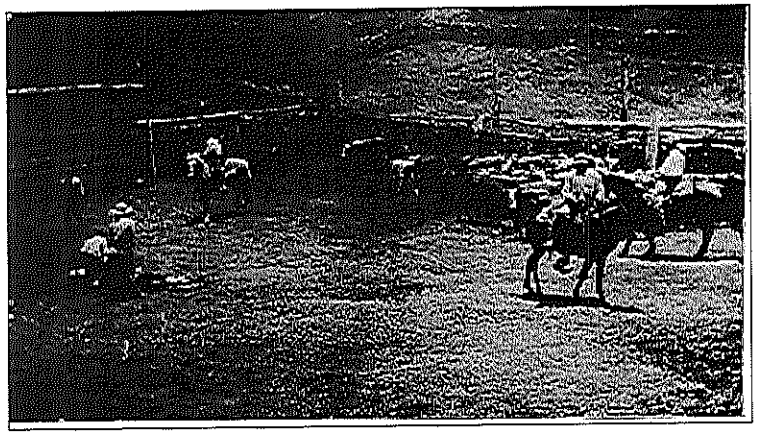

Figure 9. "Branding Pen", possibly at Hu'ehu'e Ranch; top of the photograph is *mauka* (Kona Historical Society, negative number: C 02284)

3.6 Modern Land Use

The boundary between Kohanaiki and Kaloko was until fairly recently only approximate. Kelly (1971:48) notes that when Emory and Soehren conducted their 1961 archaeological survey, the boundary was south of its current location. Additionally, one of her informants remembered that Kaloko Pond and the coast were within the *ahupua'a* of Kohanaiki, and Kaloko was "farther over, toward Huliko'a" (Kelly 1971:48). Kelly cites Beckley's (1887:256) statement that, "These fish ponds are sometimes owned, by the proprietors of two adjoining lands, the people of one owning the right to fish during the rise of the tide and the other during the ebb."

Until the construction of the Queen Ka'ahumanu Highway in the 1970s, access to the "kula kai (shoreward plains)" (Maly and Maly 2003:101) was limited to local residents. The 1924 USGS map (Figure 10) shows the *mauka/makai* road connecting the Kohanaiki Homesteads with the Kaloko fishpond, and crossing the project area at the *ahupua'a* boundary between Kohanaiki

and Kaloko. In the first half of the twentieth century, the primary method of travel was "by foot or on horse or donkey, and those who traveled the land, were almost always native residents of Kalaoa, 'O'oma, Kohanaiki, Kaloko and Honokōhau" (Maly and Maly 2003:99). Hu'ehu'e Ranch bulldozed a jeep road to the shore around 1955 (Figure 11) during the construction of the Kailua pier, and this was used primarily by the ranch employees for duties or for going fishing along the coast.

The Kaloko fishpond - leased from the Hu'ehu'e ranch - continued as a commercial fishing operation until the 1950s. During the 1970s, the pond was incorporated into the newly-established Kaloko-Honokōhau National Historic Park.

While the present project area is largely undeveloped, surrounding areas have seen increasing modern use. The Hu'ehu'e Ranch jeep road and other signs of animal husbandry activity can be seen on the 1959 USGS map (see Figure 11). More recent nearby development is largely industrial, and the Kaloko Industrial Area is just southwest of the project area, including large stores such as Home Depot and Costco. Huliko'a Road is also heavily developed, primarily as an industrial area, along a portion of the north border of the project area. Hina Lani Street runs along the south border of the project area, and leads *mauka* to a residential area (Kona Heavens) before the Palani junction (at Māmalahoa Highway), as well as leading *makai* to the modern Queen Ka'ahumanu Highway.

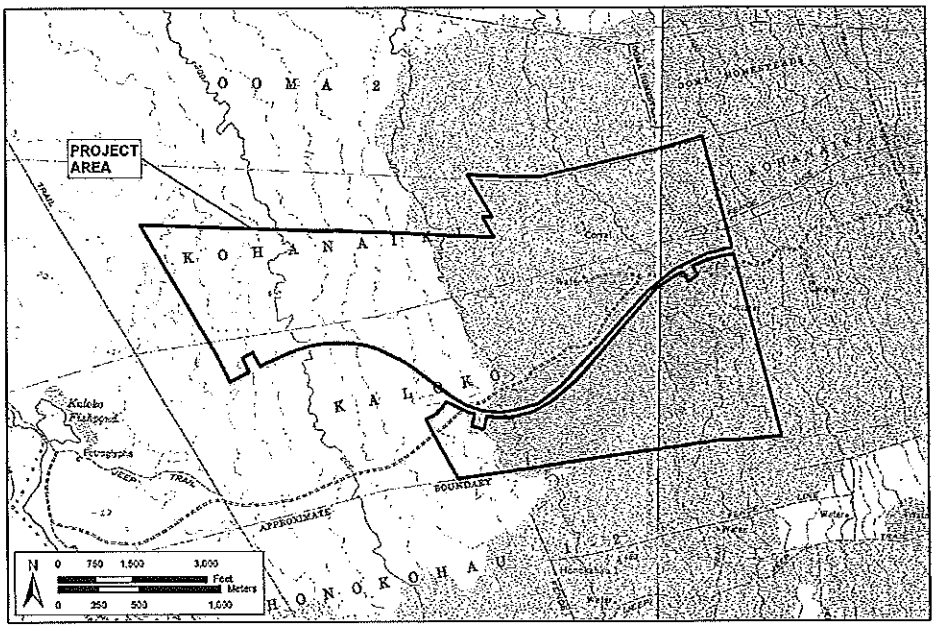

Figure 11. Portion of 1959 USGS map, Kailua and Keahole Point quadrangles, with overlay of project area showing jeep road and signs of historic/modern animal husbandry

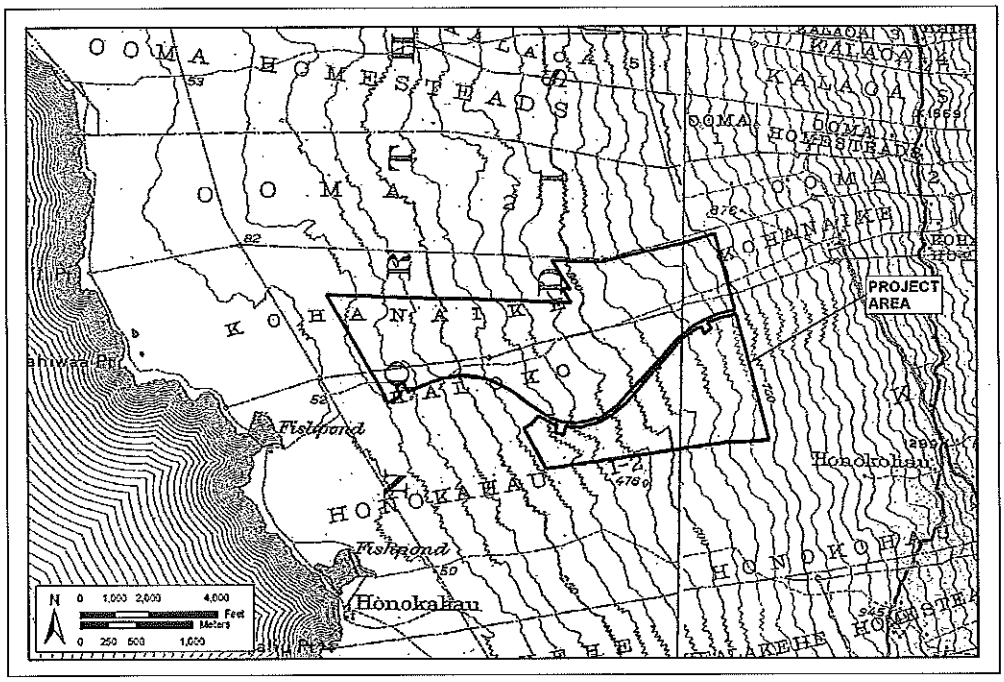

Figure 10. Portion of 1924 USGS map, Kailua and Keahole Point quadrangles, with overlay of project area

Section 4 Archaeological Research

4.1 Overview of Archaeological Studies Conducted within Kohanaiki and Kaloko

This section provides a general overview of archaeological studies in Kaloko and Kohanaiki Ahupua'a. Table 1 lists archaeological studies in this area with brief comments, while studies most relevant to the current project are discussed in additional detail in the text. The section following this discusses archaeological studies within the present project area in greater detail.

Archaeological work conducted within portions of Kohanaiki and Kaloko Ahupua'a (Figure 12) began with the early coastal survey performed by John Reinecke for the Bernice P. Bishop Museum in 1929-1930 (Reinecke 1930). This was a cursory survey in which approximate site locations and very brief site descriptions were recorded. Reinecke recorded eight sites at the coast of Kohanaiki; the sites - minimally documented and mapped - included habitation sites and a *heiau*. The next survey was undertaken by Kenneth Emory and Lloyd Soehren in 1961 (Emory and Soehren 1971). This was also a coastal survey, and focused specifically upon the coast of Kaloko, Honokōhau, and Keālakehe. In 1970 and 1971, Robert Renger and students from the University of California at Santa Barbara conducted an intensive survey of Kaloko and Honokōhau between present-day Queen Ka'ahumanu Highway and the coast (Cordy et al. 1991). This survey also included subsurface testing of selected sites. These three surveys identified a total of 94 sites within Kaloko between the coast and Queen Ka'ahumanu Highway as of 1971.

Additional archaeological work and historical research undertaken within or about Kaloko during the 1970s and 1980s include: an historical study by Marion Kelly (Kelly 1971); research relating to the establishment of the Kaloko-Honokōhau National Park (e.g. Honokōhau Study Advisory Commission 1974, National Park Service 1975); research stemming from the fieldwork conducted by Renger in 1970-71 (see the list presented in Cordy et al. 1991:2); and several reconnaissance-level studies (Ching 1980; Hammatt 1980; Soehren 1983).

Cordy (1981) conducted a survey of the coastal area (up to 1/2 mile inland) of Kohanaiki in 1975. Twelve sites were recorded including pavings, platforms, enclosures and a trail. Eleven of the sites were interpreted as habitation structures including sleeping houses, men's houses, special purpose, and a canoe house/men's house.

During the 1980s, PHRI began investigations of the entire *makai* portion of Kohanaiki Ahupua'a, bounded by its boundaries with 'O'oma 2 and Kaloko, and by the Pacific Ocean and the Māmalahoa Trail. During an inventory survey in 1986 (Donham 1986), "Fourteen previously recorded sites were relocated and 91 sites were newly identified...Habitation sites represented over half of the identified site total, and included habitation complexes, habitation/ceremonial and/or habitation/burial complexes, and temporary habitation sites" (Donham 1986:7-8). In 1991, PHRI performed data recovery of the project area (O'Hare and Goodfellow 1992). This work included: "detailed recording of (a) 31 sites (224 features) previously recorded in the project area, and (b) seven sites newly recorded during the Phase II work" (O'Hare and Goodfellow 1992:ii). Summarizing Kohanaiki settlement pattern within the zones represented by the project area, the report notes:

Table 1. Previous Archaeological Studies Within Kohanaiki and Kaloko Ahupua'a (Projects in Present Study Area are in Bold)

Source	Nature of Study	Area of Study	Finds	Comments
Reinecke 1930	Cursory survey	Coastal Survey	Briefly notes numerous sites	All sites *makai* of present project area
Emory & Soehren 1971	Cursory survey	Coastal Survey	Briefly notes numerous sites	All sites *makai* of present project area
Kelly 1971	Historical survey and background	Kaloko and Kuki'o Ahupua'a	Background study	Good background study
Renger 1971	"Field Notes" of "*Mauka* excavations"	"*Mauka* excavations"	"Field Notes" describe several sites	No site location map thus hard to be sure where sites are
Soehren 1979	Letter Report Reconnaissance Survey	Kaloko Access Road Corridor (Hina Lani Street)	No finds	-
Soehren 1980a	Letter Report Reconnaissance Survey	Kaloko lowlands	No finds	-
Soehren 1980b	Letter Report Reconnaissance Survey	Kaloko Access Road Corridor	Discusses 3 stepping stone trails, 2 *ahu* & a lava tube complex	Hina Lani Street Letter Report not actually seen
Hammatt 1980	Archaeological Reconnaissance	410 acre parcel	Identified 2 sites	*Mauka* of present project area
Barrera Jr. 1983	Archaeological Reconnaissance	TMK 7-3-9:19	No finds	No map
Soehren 1983	Archaeological Reconnaissance Letter Report	-	-	-
Kennedy 1983	**Archaeological Reconnaissance**	**Within present project area**	**Identifies 27 sites**	**Within present project area**
Kennedy 1984	**Intensive Archaeological Survey**	**Within present project area**	**Results of investigations of 25 sites**	**Within present project area**
Barrera Jr. 1985	**Archaeological Survey**	**409 acres 700 to 1080' elevation**	**58 sites**	**Within present project area**

Source	Nature of Study	Area of Study	Finds	Comments
Donham 1986	Archaeological Reconnaissance Survey	470-acres *makai* of Queen K Hwy	105 sites	Kohana-iki development
Rosendahl & Haun 1987	Archaeological Reconnaissance Survey	3 1-acre parcels, 2 in present project area	Their project area *mauka* of present project area had one site	Water tanks along Hina Lani Street
Barrera Jr. 1988	Archaeological Excavations	YO Project Area	60 sites	*Mauka* of present project area
Rosendahl, M 1989	Archaeological Inventory Survey	200 ft.-wide corridor along boundary separating O'oma 2 and Kohanaiki	Identified 4 sites; **site 5699 extends into current project area**	Adjacent to and north of present project area
Rosendahl 1989a	Letter Report Addendum to Archaeological Inventory Survey	Addl info re: site 13493 stepping stone trail by *makai* tank	Identified one *pāhoehoe* slab trail (site 13493)	Water tank *makai* of present project area
Rosendahl 1989b	Field Inspection	Kaloko Mauka Parcel # 1	Identified 4 sites	-
Rosendahl 1989c	Field Inspection	Kaloko Mauka Parcel # 2	No sites identified	-
Rosendahl & Walker 1990	Addendum to Archaeological Inventory Survey	Addl info re: site 13493 trail by *makai* tank	Addl info re: site 13493 trail by *makai* tank	Water tank *makai* of present project area
Rosendahl & Walker 1991	Archaeological Field Inspection	Industrial crusher site, 2 adjacent 10 acre parcels	Identified a trail with two cairns	South of present project area
Barrera Jr. 1991	Archaeological Inventory Survey & Data Recovery Report	800 to 1100'	Identified 61 sites	*Mauka* of present project area
Cordy et al 1991	An Ahupua'a Study: The 1971 Archaeological Work at Kaloko	Kaloko-Honokōhau National Park	94 sites identified	*Makai* of present project area
Kennedy 1991	Surface Reconnaissance	Long thin industrial development	No significant finds	*Makai* of present project area

Source	Nature of Study	Area of Study	Finds	Comments
Drolet & Schilz 1991	Archaeological Inventory Survey	8.8 acres in O'oma 2	29 sites identified Site -16103 extends into project area	Adjacent to and north of present project area
Barrera Jr. 1993	Archaeological Inventory Survey	5.7 acres; 1450 to 1630' elevation	Identified 40 features of Kona Field System	*Mauka* of present project area
Fager & Graves 1993	Archaeological Inventory Survey	Kaloko Industrial Park parcel	Identified 17 sites with 60 component features	*Makai* of present project area, south of Hina Lani Street
Fager & Rosendahl 1993	Interim Report Archaeological Inventory Survey	Kaloko Industrial Park parcel; 15+ acres	Identified 17 sites with 60 component features	Just *makai* of present project area, south of Hina Lani Street
Henry & Graves 1993	**Archaeological Inventory Survey**	**Transmission line project *mauka* side of Queen K Hwy.**	**Identified 10 sites within project area**	**Within present project area**
O'Hare & Rosendahl 1993	Report on burials	On coast	Report on burials	Kohana-iki Resort project
Rosendahl 1993	Archaeological Field Inspection	Kaloko Mauka Parcel	4 sites discussed	-
Nees & Williams 1995	Archaeological Investigations	110 acres, 2100 to 2900' elevation	Identified enclosure, lava tube, terrace, wall, mounds	*Mauka* of present project area
Walsh & Hammatt 1995	Archaeological Inventory Survey	Queen K Hwy Right-of-Way	Identified 9 sites adjacent to *makai* side of Hwy in Kohanaiki & Kaloko	*Makai* of present project area
Colin et al. 1996	**Archaeological Inventory Survey**	**224 acres *makai* of present project area**	**Identified 55 sites**	**Within present project area**
Rechtman 1998	Archaeological Field Inspection	2400-2500' elevation	No finds	*Mauka* of present project area
Rechtman & Henry 1999	Archaeological Inventory Survey	1450-1620' elevation	Identified 15 sites	*Mauka* of present project area

Source	Nature of Study	Area of Study	Finds	Comments
Wolforth 1999	Monitoring Report	HELCO Keāhole-Kailua Transmission line corridor	Describes one site 21258	Says Walsh & Hammatt previously id'd site as 19946 (on *makai* side of hwy)
Haun & Henry 2000	Archaeological Inventory Survey	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre parcel	45 sites with 81 features	*Makai* of present project area south of Hina Lani Street
Rosendahl 2000	Archaeological Assessment	2435-2730' elevation	No finds	*Mauka* of present project area
Clark & Rechtman 2002	Archaeological Inventory Survey	1200' to 1600' elevation	Identified 5 sites	*Mauka* of present project area
Haun & Henry 2002	Data Recovery Plan	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre	Data Recovery Plan addresses 8 specific sites	*Makai* of present project area south of Hina Lani Street
Rechtman & Rivera 2002	Archaeological Assessment	3-7-3-26:4; 3,100'	No finds	*Mauka* of present project area
Cobb et al. 2003	**Archaeological Assessment**	**TMK: 7-3-09:25, 26 & 28 at Kaloko and Kohanaiki (400 acres)**	**Briefly identifies 154 features**	**Descriptions quite brief; map hard to correlate with sites found in present survey**
Haun 2003	**Archaeological Assessment**	**400-Acre Portion of TMK 7-3-09:28 Kaloko**	**Identifies 8 sites (63 features) in present project area**	**Helicopter flight overhead led him to focus on open *'a'ā* area**
Haun et al. 2003	Data Recovery Report	Kaloko Industrial Park TMK: 7-3-51:60; 102-acre	Data Recovery Report addresses 8 specific sites	*Makai* of present project area south of Hina Lani Street
Moore & Kennedy 2003	Archaeological Inventory Survey	Roadway Corridor	Identified 1 site (23973) 2 mounds	South boundary of project area
Puette & Dye 2003	Archaeological Inventory Survey	22 acres 2100 to 2400' elevation	No finds	*Mauka* of present project area
Rechtman 2003	Archaeological Assessment	3-7-3-26:5; 3,100' elevation	No finds	*Mauka* of present project area

Source	Nature of Study	Area of Study	Finds	Comments
Elmore et al. 2004	Archaeological Inventory Survey	1400' elevation	Identified one historic site 24133	*Mauka* of present project area
Shideler & Hammatt 2005	**Archaeological Field Inspection and Literature Review**	**1,200+ Acres in Kaloko and Kohanaiki**	**Numerous pre-Contact sites observed, including: habitations, agricultural features, petroglyphs, boundary walls, and burials**	**Within present project area**
Wolforth et al. 2005	Archaeological Inventory Survey	TMK: [3] 7-3-09: 032	A total of 89 sites were identified, consisting of burials, perm. habitation, temp. habitations, religious sites, trails, boundary walls, and agricultural sites	*Mauka* of present project area
Nelson et al. 2006	Archaeological Inventory Survey	TMK:3-7-3-009:007	Re-recorded site 16103, which extends into project area	Adjacent to and north of present project area; **one site extends into project area**

> The data recovery work indicates that permanent habitation sites between Puhili and Wawahiwaa Points are concentrated in the coastal zone, near the shoreline. In the coastal area south of Wawahiwaa Point permanent habitation sites were near the shoreline and further inland. Temporary habitation sites were present in all areas of the coastal zone and in the barren rockland zones. The radiocarbon date ranges indicate that sites in the northern coastal zone might have been inhabited as early as A.D. 1020. Sites in the southern coastal zone may have been inhabited as early as A.D. 1370, and sites in the barren rockland zones may have been inhabited as early as A.D. 1180. In the barren rockland zones, use of the sites was terminated before the historic period, and in the coastal zone most of the sites were not used in the historic period. (O'Hare and Goodfellow 1992:ii)

In 1985, Barrera (1985) surveyed approximately 409 acres within Kaloko and Kohanaiki Ahupua'a; the 409-acre parcel is located between Māmalahoa Highway and Queen Ka'ahumanu Highway, 750 meters *mauka* of the present project area. Four sites were recorded in Kaloko,

including an enclosure, a lava tube cave, a wall and a platform (possible burial). Fifty-five sites were recorded within Kohanaiki and include mounds, platforms, habitation complexes, walls, and terraces. A portion of the study area included the historic period Kohanaiki Homestead. Barrera's site #59 comprises constructions associated with the homestead and is described as a "series of Habitation areas enclosed by large stone walls." No estimate is given of the ages of the other sites.

In 1987, Paul H. Rosendahl Inc. accomplished an archaeological reconnaissance survey of three one-acre parcels - proposed water tank sites - in Kaloko (TMK: 7-3-09:Por.1,17) (Rosendahl and Haun 1987), along the south side of the then "main access road between Queen Ka'ahumanu Highway and Kona Heavens Subdivision" - i.e. the present Hina Lani Road. The parcels were located at 350 ft. a.m.s.l., 630 ft. a.m.s.l., and 910 ft. a.m.s.l. Only one site (SIHP No. 10-28-10887) - an historic wall interpreted as a boundary or cattle wall - was recorded within the mauka-most parcel. Subsequently, in 1989, an additional water tank site parcel (TMK: 3-7-3-10:Por.17) - measuring 360 ft. north/south and east/west - was subject of an archaeological inventory survey (Rosendahl 1989). The parcel bordered the north side of the then "proposed Kamanu Street extension in the Kaloko Light Industrial Park" at the south boundary along Hina Lani Road. One site was recorded and designated SIHP No. 50-10-27-13493:

> a steppingstone trail segment measuring 7.5 m (24.6 ft.) long (E-W) by 0.6-0.7 m wide (1.97-2.30 ft.) (N-S)...located on a section of aa lava...The segment consists of approximately six flat and roughly round pahoehoe slab steppingstones set on worn aa gravel. The steppingstones measure c. 0.4 m (1.31 ft.) in diameter by 0.1 m (0.33 ft.) thick. The trail is oriented c. 159 degrees Az. (magnetic). No portable remains were present in association with the trail. The trail appears to be prehistoric, and appears to have been used as a secondary transportation route. (Rosendahl 1989:1)

In 1988, Cordy et al. (1991) began preparing a study of Kaloko Ahupua'a for the new Kaloko-Honokōhau National Park. The study was based on Renger's 1971 fieldwork conducted for planned development of coastal Kaloko for Hu'ehu'e Ranch. The fieldwork "included survey work in the intermediate and upland zones of Kaloko, which located additional sites, extensive excavation in the coastal area, and some excavation in the intermediate and upland sites" (Cordy et al. 1991:2). Renger identified, and in some cases re-identified, 94 sites that included 59 sites in the Coastal Zone, 30 sites in the Middle Zone, and five *mauka/makai* trails that crossed both zones and continued heading inland. As only "summary papers" had been previously written, the monograph published in 1991 includes the 1971 fieldwork data and resultant analyses, and additional fieldwork conducted by Cordy and Hitchcock in the 1970s and 1980s (Cordy et al. 1991:2, 44).

In 1991, Archaeological Consultants of Hawai'i (Kennedy 1991) performed a reconnaissance survey of a narrow corridor - 500 ft. north/south by 7260 ft. *mauka/makai* (TMK: 7-3-09:15) - in Kohanaiki extending *mauka* from Queen Ka'ahumanu Highway, located adjacent to the northern boundary of the present study area. No sites or features were observed; seven caves "were examined to term and were determined to be devoid of cultural materials" (Kennedy 1991:C-1).

In 1991 William Barrera produced an archaeological inventory survey and data recovery report of an extensive area just inland (*mauka*/east) of the present study area in which he identified 61 sites. These sites were rather clumped in the east central portion of his project area.

Rosendahl and Walker (1991) carried out an archaeological field inspection for proposed Kaloko Industrial crusher sites just south of Hina Lani Street at an elevation of approximately 450 ft a.m.s.l.. A trail and two associated cairns were identified.

In 1993, Paul H. Rosendahl Inc. conducted an inventory survey (Fager and Graves 1993) of an approximately 15-acre parcel adjacent to, and *mauka* of, the Kaloko Industrial Park, which includes a road corridor extended from the main project area to Kamanu Street. The survey recorded 17 sites incorporating 60 component features. The sites were judged

> ...in poor to good condition and comprised the following formal types: terraces, modified outcrops, mounds, walls, caves, pahoehoe excavations, cairns, filled cracks, enclosures, and a trail. The formal types comprised the following functional types: animal husbandry, temporary habitation, agriculture, marker, quarry, and transportation. (Fager and Graves 1993:ii)

A series of studies (Haun and Henry 2000, 2002; Haun et al. 2003) were carried out on a 102-acre Kaloko Industrial Park parcel south of Hina Lani Street. Of note are the fairly dense and widely distributed site concentration and also extensive areas of both *'a'ā* flow and bulldozing.

In recent years a number of studies have been undertaken in the Kaloko Mauka lands (east and upslope from the present project area) including studies by Barrera (1993), Nees and Williams (1995), Rechtman (1998), Rechtman and Henry (1999), Rosendahl (2000), Clark and Rechtman (2002), Rechtman and Rivera (2002), Puette and Dye (2003), Rechtman (2003), and Elmore et al. (2004).

In 2005, Wolforth et al. conducted an archaeological inventory survey of the northern portion of the Kaloko Heights Project (TMK [3] 7-3-09: 032), located approximately 1,000 m east of the current project area. A total of 89 sites were identified, consisting of burials, permanent habitations, temporary habitations, religious sites, trails, boundary walls, and agricultural sites. A historic wall that runs along the *ahupua'a* boundary between Kaloko and Kohanaiki extends from TMK parcel 32, adjoining the current project area to the east, into TMK parcel 25, within the current project area.

4.2 Archaeological Studies Conducted within the Present Project Area

The following is a summary of archaeological studies conducted within the current project area, discussed in chronological order. Table 1 lists in bold historic properties previously identified in the current project area

Survey work was undertaken in 1970-71 by Renger inland of the highway - i.e. that middle zone of Kaloko that includes a portion of the present study area. Although the findings of much of this fieldwork within the middle zone were written up in detail (Cordy et al. 1991), the findings from the survey sample conducted specifically within the project area (i.e. that portion of the middle zone situated on the inland side of the Queen Ka'ahumanu Highway) were not included because, "regrettably... it appears that the maps and survey records have been misplaced

since the end of the 1971 field season" (Cordy et al. 1991:340). Renger's summary of the findings from that part of the survey indicated that fifteen features were identified:

> Very few sites were discovered within the "transitional middle zone" ... between the coastal and upland exploitation zones ...Seven lava tube shelters, four trails (coast-upland), three platforms, two cairns ... two low-walled enclosures, and an L-shaped structure were recorded. (cited in Cordy et al. 1991:340)

These sites are presumably the subject of a set of Renger's (1971) "Kaloko Field Notes" that begins "*Mauka* Excavations" but in the apparent absence of any site location map it is difficult to relate these notes to specific sites in the field.

It is our understanding that Lloyd Soehren conducted a reconnaissance survey in 1979 of the Kaloko access road corridor, understood as the current alignment of present Hina Lani Street, but identified no sites.

In 1983, Joseph Kennedy conducted a reconnaissance and subsequent intensive survey (1984) of a parcel within the *makai* portion of the present project area. The 1983 reconnaissance located and briefly described 27 sites. These sites included 17 lava tubes, three *cairn* or cairns, two walls, two platforms, an enclosure, a modified outcrop, and a trail. The 1984 intensive survey identified:

> 45 separate cave openings and approximately 200 chambers in these caves. In addition there were 4 walls recorded, 5 enclosures, 13 platforms, 9 cairn, 2 trails and 2 sets of petroglyphs. Out of the 79 separate features on the property, 30 were judged to be worthy of re-investigation ... the remaining 49 sites that were not reinvestigated were comprised almost exclusively of relatively shallow caves with little or no evidence of cultural remains or associated modifications. (Kennedy 1984:18)

Many (but not all) of the sites identified in 1984 are described and some of these sites were not mapped. Excavations were carried out in three caves (Sites 11, 22 and 49 in the Kennedy 1984 numbering system). Of the 25 sites for which information is presented in the Kennedy 1984 study, 22 sites were recommended for no further work and three (Kennedy 1984 site #s 11, 22 and 32) were recommended for preservation.

In 1989, Margaret Rosendahl conducted an archaeological inventory survey of a 200 ft.-wide corridor along the boundary separating O'oma 2 and Kohanaiki, north of the project area, for a water system. Survey results included the identification of four sites that included quarrying pits, a ceremonial/habitation complex, a marker, and a historic wall. The wall, SIHP No. -5699, ran along "the inland boundary of the survey corridor" (Rosendahl 1989:13). During the current survey, 15 m of the wall's south end extends within the project area, and continues roughly north for at least 500 m. The rubble-fill method of construction indicates the wall is historic. No further work was originally recommended, although possible inclusion into landscaping was suggested for consideration (Rosendahl 1989:14).

In 1991, Drolet and Schilz conducted an archaeological inventory survey of 8.8 acres in O'oma 2, north of and adjacent to the current project area. Survey findings included the identification of 29 sites including two cave complexes, SIHP Nos. -16103 and -16104, that extend into the current project area. Nelson et al. (2006:66) found that the two caves connect and

actually consist of one subsurface complex. They referred to the sites as SIHP No. -16103. Drolet and Schilz (1991:27-28) determined that the sites were significant and their project, as planned, would avoid the sites and provide a "10 meter buffer zone" around them. Nelson et al. (2006:66) describe the site as containing "several architectural modifications, a plethora of cultural debris, and a single human burial." They determined that "site 16103 retains integrity of location and is in good condition for an archaeological ruin" (Nelson et al 2006:66).

In 1993, Henry and Graves carried out site identification along a Keāhole to Kailua 69 kV transmission line, which comprised a 50-100 ft wide alignment on the *mauka* (east) side of Queen Ka'ahumanu Highway. Nine sites were identified within the current project area. During the current inventory survey only three (SIHP Nos. -15324, -15325, and -15329) of the nine sites were relocated. It is believed that the seven sites not relocated were either situated outside of the current project area, within the *mauka* (eastern) road easement, or were destroyed (via bulldozing) during the installation of new powerlines along the eastern side of Queen Ka'ahumanu Highway.

In 1995, CSH conducted an archaeological inventory survey with limited subsurface testing within a narrow strip of land, averaging 300 ft wide, along Queen Ka'ahumanu Highway between Palani Road and the Keāhole Airport entrance road (Walsh and Hammatt 1995). Three sites were identified in Kohanaiki: two trails and a set of three cairns. One of the trails - a *mauka-makai* trail - had been previously identified and designated SIHP No. 50-10-27-15324. The site is described as consisting of:

> ...two converging trail segments designated Features A and B...Both trail segments extend in a roughly *mauka-makai* direction, but angle toward each other and converge into one trail that continues inland. The point where the two trails meet is located at the edge of the bulldozed portion of the present highway right of way, 164 feet (50 m.) from the *makai* edge of the highway pavement...On the *mauka* side of the highway, the trail was observed at the edge of the bulldozed portion of the power line (the new right-of-way boundary) and continuing inland at 65 degrees T.N. for at least another 100 feet (30 m.). (Walsh and Hammatt 1995:51)

This trail site is located within the present study area.

In 2003, Archaeological Consultants of the Pacific, Inc. (Cobb et al. 2003) conducted an archaeological assessment of TMK (3) 7-3-009: 025, 026, and 028. One hundred fifty-four (154) features were identified and included "caves, walls, mounds, platforms, enclosures, trails, *cairn*, "C"-shaped structures, possible *heiau*, terraces, alignments and modified outcrops" (Cobb et al. 2003:1). Each feature was identified with a number prefaced with "TF", and descriptions included feature type, a brief description, possible function and a preliminary significance evaluation. The report map does not show the location of particular sites found during the survey but has colored points for sites indicating "High Concern, Potential High Concern, and Minimal Concern" (Cobb et al. 2003:5). The *mauka* portion of the current project area was included in the survey and several site tags from the 2003 survey were found in sites recorded during the current project (see below). One site, TF142, a cave with a small entrance and indeterminate function, was thoroughly surveyed by CSH in 2007; no cultural materials or modifications were present.

Haun (2003) conducted an archaeological assessment of a portion of the current project area, largely via helicopter to cover the *'a'ā* terrain, but also by foot in the thicker vegetation. He identified eight sites, all of which correlate to sites presented in the CSH archaeological inventory survey for TMK 28 (Esh et al. 2008).

In 2005, CSH completed an archaeological field inspection of a 1200+ acre project area in Kaloko and Kohanaiki [TMK (3) 7-3-009:017, 025, 026, and 028] that included the current project area. Numerous pre-Contact sites including habitations, agricultural features, petroglyphs, boundary walls, and burials were observed (Shideler and Hammatt 2005).

In 2007 and 2008, CSH completed fieldwork for the four archaeological inventory surveys within Kaloko and Kohanaiki Ahupua'a (TMK: [3] 7-3-009:017, 025, 026, 028), that are the companion reports for this CIA. Given the large size of the total project area (over 1,100-acres), a decision was made to split the archaeological inventory survey reports by individual TMK parcel, producing a total of four reports.

In the 224+ acre project area in TMK [3] 7-3-009:017, a total of 59 historic properties were identified; 53 of the historic properties were previously identified and six were newly recorded during the inventory survey investigation. CSH had previously conducted an archaeological inventory survey (Colin et al. 1996) in the same project area in 1996 with limited subsurface testing for Kimura International; the project was terminated during the review process. Fifty-five sites were identified in 1996. All identified sites were of pre-Contact traditional Hawaiian origin and included the following site types: cairn, simple agricultural features, recurrent and temporary habitation sites, trails, enclosures, walls, and a quarry. During the 2007 inventory survey, two sites (SIHP Nos. -20706 and -20741) identified by Colin et al. were determined to be outside of the project area, likely due to the lack of GPS technology during the 1996 survey. One site, SIHP No. -20741, is within TMK parcel 25, another section of the current project area (Bell et al. 2008).

In the 360.131 acre parcel (TMK: [3] 7-3-009:025), a total of 121 historic properties were identified; two of the historic properties were previously identified and 119 were newly recorded during the inventory survey investigation (Bell et al. 2008).

In the 194.324-acre parcel (TMK: [3] 7-3-009:026), a total of 120 historic properties were identified; six of the historic properties were previously recorded and 114 were newly recorded as part of the inventory survey investigation (Bell et al. 2008).

In the 363.106-acre parcel (TMK: [3] 7-3-009:028), a total of 41 historic properties were identified. All sites were newly recorded as part of the inventory survey investigation; eight of the historic properties were previously noted in an archaeological assessment by Haun (2003), and some features were also noted by Cobb et al. (2003) (Esh et al. 2008).

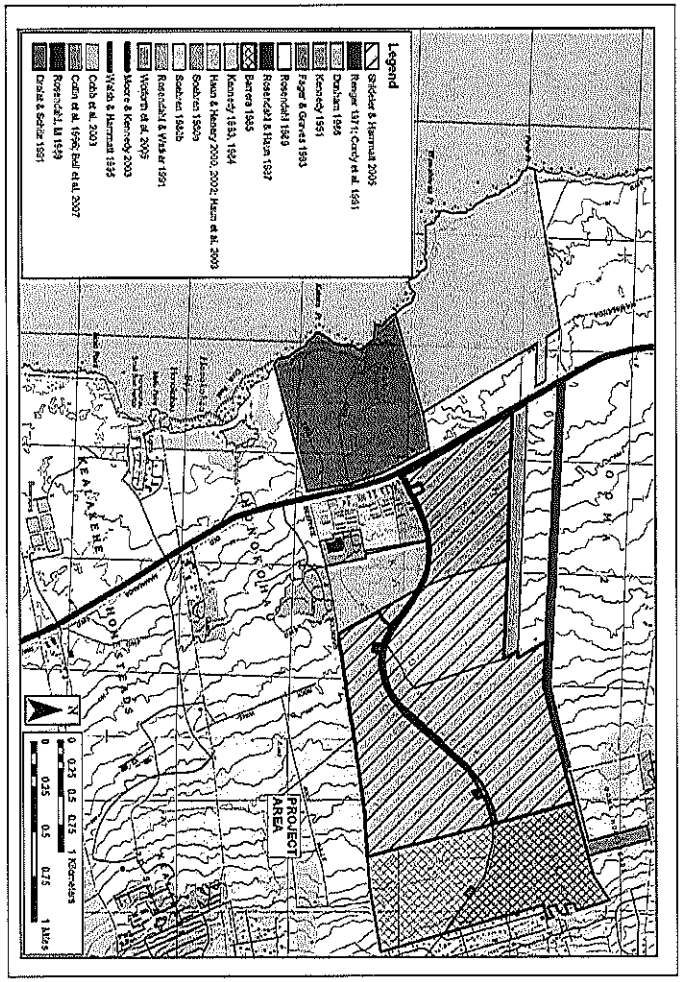

Figure 12. Map of previous archaeological studies in the project area and its vicinity

Section 5 Community Consultation Effort

Throughout the course of this CIA, 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 cultural resources and practices specifically related to the project area. A number of attempts (3-7) were made to contact individuals, organizations, and agencies apposite to the CIA for Kohanaiki. This effort was made by letter, e-mail, telephone and in person contact. In the majority of cases, letters along with a map and aerial photograph of the project area were mailed with the following text:

> At the request of Stanford Carr Development, Cultural Surveys Hawai'i, Inc. (CSH) is conducting a Cultural Impact Assessment (CIA) for a 1,150 acre project located in Kohanaiki and Kaloko Ahupua'a, North Kona District, on the Island of Hawai'i, Tax Map Key: [3] 7-3-009:17,25,26 and 28. The proposed project area is *mauka* (east) of Queen Ka'ahumanu Highway and is surrounded mostly by undeveloped land. The proposed project area extends *mauka* from the highway to within approximately 1/2 mile (900 meters) of existing residences in the Kona Heavens subdivision area (Anini Street, Manu Mele Street, Kohanaiki Road). The proposed project area is bisected by Hina Lani Street (*mauka/makai* road) and is nestled between the Kohanaiki Industrial Park and Kaloko Industrial Park (i.e. Costco and other big box retailers). See attached USGS map and aerial photograph of the project.
>
> The developers' proposed plans includes a residential community with construction of 5,000 new single- and multi-family residential units sizing at low, medium and high-densities, centralized commercial and neighborhood retail centers, an array of recreational facilities (e.g. parks, trails, open spaces), a new elementary school, a middle school, and associated infrastructure (e.g., new roadways, utilities, drainage, wastewater and potable and non-potable water distribution systems).
>
> The purpose of this cultural study is to assess potential impacts to cultural practices and resources as a result of proposed development in Kohanaiki Ahupua'a. We are seeking your kōkua 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 area, both past and ongoing.
> - Cultural associations of the project area, such as legends and traditional uses.
> - Referrals of *kūpuna* or elders and *kama'āina* 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 results of the community consultation effort are presented in Table 2 below. Section 6 below presents the community responses to CSH.

Table 2. Community Contacts Summary

Name	Affiliation, Background	Comments
Ako, Mr. Val	Fisherman, lineal descendant	CSH sent letter and maps on Mar. 12, 2008. Mr. Ako shared his *mana'o* on March 27. See Section 6 below.
Carlson, Mr. Carl	Former general manager of Hu'ehu'e Ranch	CSH emailed letter and maps on Mar. 14, 2008. CSH spoke with Mr. Carlson the same day and he agreed to draw the borders of Hu'ehu'e Ranch on a TMK map, for the year 1955. CSH faxed the maps for Mr. Carlson to draw the borders on March 17. Mr. Carlson emailed CSH on Mar. 18, and said he would work on maps when he has time.
Davis, Ms. Morgan	State Historic Preservation Division, Hawai'i Office	CSH sent letter and maps on Feb. 26, 2008
Flores, Mr. E. Kalani	Lecturer, University of Hawai'i and trail expert	CSH sent email inquiry regarding historic trails on Feb. 24, 2008. Mr. Flores replied on Mar. 10, providing information about descendants and organizations. He requested to be notified of findings and of the report when it is done.
Haleamau, Mr. Karin	*Paniolo* for Hu'ehu'e Ranch and lineal descendant, as well as traditional fisherman	CSH sent letter and maps on Feb. 25, 2008. CSH called on Mar. 13, and interviewed Mr. Haleamau on March. 20. An additional statement was made by Mr. Haleamau on April 15. See Section 6 below.
Keanaaina, Mr. Duane	Lineal descendant	CSH sent letter and maps on Feb. 25, 2008. CSH interviewed Mr. Keanaaina on March 26. See Section 6 below.
Keanaaina, Rev. Norman	Lineal descendant	CSH sent letter and maps on Feb. 25, 2008. CSH interviewed Rev. Keanaaina on April 9. See Section 6 below.

Name	Affiliation, Background	Comments
Keka, Mr. Peter	Multi-generational ties to Kaloko-Honokōhau fishponds and surrounding lands with knowledge regarding traditional stonework and caring for fishponds	CSH sent letter and maps to Mr. Keka via Richard Boston, his supervisor at Kaloko-Honokōhau National Park, on Feb. 25, 2008. Mr. Keka shared his *mana'o* on March 21. See Section 6 below.
Kuali'i, Mr. Melvyn Kaleo	Lineal descendant and member, Hawai'i Island Burial Council	CSH sent letter and maps on Feb. 25, 2008. CSH telephoned on Mar. 18. CSH sent email on April 14.
Kunewa, Mr. Herman and Mrs. Iris	Lineal descendants and educators who grew up in Kohanaiki.	CSH sent letter and maps on Feb. 26, 2008. On Mar. 12, 2008, Mr. Kunewa supplied a statement. See Section 6 below.
Lamont, Ms. Joan	Vice President of Beautification, Kona Outdoor Circle	CSH contacted Ms. Lamont by phone on April 14, 2008 regarding proposed project area. CSH mailed letter and maps on April 15.
Lee, Mrs. Elizabeth	Master *lauhala* weaver, lineal descendant	CSH sent letter and maps on Feb. 26, 2008. CSH met Mrs. Lee on March 19. Interview pending approval.
Lee, Mr. Reggie	Lineal descendant; works with DNLR; son of Elizabeth Lee	CSH sent letter and maps on Feb. 26, 2008. Mr. Lee called on March 12, for his mother and brother Robert. CSH spoke to the Lees on Mar. 19, where they declined to make a cultural statement at that time and requested in-depth information regarding the proposed development.
Machado, Ms. Wendy	Cultural Historian, State Historic Preservation Division	CSH emailed Ms. Machado on March 14, 2008 to request a list of lineal descendants for Kaloko and Kohanaiki. Ms. Machado responded on March 25, saying she had a list of cultural descendants. Ms. Machado provided the list of cultural descendants for Kohanaiki on March 31. Ms. Machado emailed on April 1 to confirm she received project information and maps through Ms. Morgan Davis and to ask clarification of project TMK and provide several references.

Name	Affiliation, Background	Comments
Mahi, Mr. Arthur	*Paniolo* and Native Hawaiian cultural practitioner	CSH called Feb. 26 and sent letter and maps on Feb. 27, 2008. CSH interviewed Mr. Mahi on March 20. See Section 6 below.
McDonald, Mrs. Ruby Keanaaina	Lineal descendant and Office of Hawaiian Affairs community resource coordinator	CSH sent letter and maps on Feb. 25, 2008. CSH sent another letter and maps on March 25, 2008 to Mrs. McDonald's home address as she requested information as a lineal descendant. CSH interviewed Mrs. McDonald on April 15. Interview pending approval.
Nāmu'o, Mr. Clyde:	Administrator, Office of Hawaiian Affairs	CSH sent letter and maps on Feb. 25, 2008. See Section 6 below for OHA's response letter.
Nazara, Mrs. Cynthia	Lineal descendant and member of Hawai'i Island Burial Council	CSH sent letter and maps on Feb. 25, 2008. CSH interviewed Mrs. Nazara on March 24. See Section 6 below.
Paik, Ms. Linda Kaleo	Cultural Specialist, History and Culture, State Historic Preservation Division	CSH sent letter and maps on Feb. 25, 2008.
Punihaole, Mr. Robert	Hawaiian cultural practitioner with multi-generational ties to the Kekaha region and North Kona district	CSH sent letter and maps on March 25, 2008. CSH called on April 9. Mr. Punihaole declined to make statement as Kohanaiki is not his *ahupua'a*.
Springer, Ms. Hannah Kihalani	Former Office of Hawaiian Affairs trustee and a member of Kahu Ku Mauna, the cultural advisory group which advises the Mauna Kea Management Board. Her great-great grandmother, Luka Hopula'au, was the first wife of John Avery Maguire, the founder of Hu'ehu'e Ranch.	CSH mailed letter and maps on March 25, 2008. CSH reached Ms. Springer by telephone on April 22, and she shared the following: "Although my family is certainly connected to Hu'ehu'e Ranch and the surrounding lands, I don't know much about Kohanaiki and the project area. But you might check the development of the *makai* lands for additional information. My great-great grandmother, Luka Hopula'au Maguire, was born on Kohanaiki. I learned this from the Mormon church…There is much written on Kekaha lands and you could use that for information."

Name	Affiliation, Background	Comments
Soehren, Dr. Lloyd J.	Archaeologist, expert on place names	CSH called on Mar. 14, 2008, and emailed letter and maps the same day. Dr. Soehren replied on April 18 with the following statement via email: "...I once collected and propagated an *'ohe makai* seed from Kaloko, at about that elevation. The area contains a remnant dry land forest...Place names are scarce in that region, most being either at the shore or higher among the *kuleana*."
Van Gieson, Mr. George	*Hōlua* (sledding) expert for the island of Hawai'i and former member of Hōlua Project Incorporated, which sought to preserve *hōlua* throughout Hawai'i Island	CSH sent letter and maps on Feb. 26, 2008. CSH called on April 28 and Mr. Van Gieson supplied a cultural statement. See Section 6 below.
Ursua, Kumu Larry	Hawaiian cultural practitioner and Kumu kāne hula	CSH sent letter and maps on March 19, 2008. CSH called on April 9, and interviewed Kumu Larry on April 15. Interview pending appoval.
Young, Mr. Charles	Chair, Hawai'i Island Burial Council	Sent letter and maps on April 12, 2008. CSH called Mr. Young on April 28 and left message.

Section 6 Community Responses

Kama'āina and *kūpuna* with knowledge of Kohanaiki and Kaloko Ahupua'a and the proposed project area were contacted for participation in this assessment. The approach of CSH to cultural impact studies affords these community contacts an opportunity to review transcriptions and/or interview notes and to make any corrections, deletions or additions to the substance of their testimony.

Presented below are brief backgrounds of each participant, followed by their comments and concerns about the proposed project area. OHA's response letter follows the participants' comments and concerns.

6.1 Kama'āina Interviews

6.1.1 Mr. Herman Kunewa

CSH interviewed Mr. Herman Kunewa on March 12, 2008 by telephone. His statement represents his *mana'o* (thoughts, ideas, theories) as well as that of his wife Iris. They both have *'ohana* who hail from Kohanaiki. Mr. Kunewa was raised in Kohanaiki, and works as an educator along with Mrs. Kunewa.

When CSH inquired if Mr. and Mrs. Kunewa had any comments about the proposed project, Mr. Kunewa at first declined to make a statement. "We believe in taking a stand this time. You are not the first to approach us about cultural sites and practices, and it doesn't tell us how we can live," he said. "Hawaiians are having a hard time. We are just learning to get back our land."

Mr. Kunewa questions the validity of the proposed project. "The infrastructure in Kona is bad," he pointed out. "The resources are dwindling. When a development comes in, the bottom line is money. That's not what we want to see. Let them back off a bit and let Kona breathe. Let the *iwi kūpuna* (ancestral remains) rest in peace."

Mr. Kunewa emphasized that he is not blindly against development, but he is very much aware of the consequences of uncurtailed and ad hoc building.

> Specifically, we go through this apprehension. We are looking, reading about what is going on. We are very adamant about what is going on. We already work with the families of Kohanaiki, so that they are responsible for all the major sites on it. We are not totally against the development, but we are not for it.

Because he and Mrs. Kunewa are both teachers, they do their best to teach the young, both their children and their students. "We talk to them about the concept of the *ahupua'a*," he said. To understand the *ahupua'a* properly, one needs to also understand how it should look.

> When you go *makai*, and you look up and see development, or look down from *mauka*, and you see construction, the *ahupua'a* is already ruined. If you overdevelop it, aesthetically speaking, you also ruin it. It's all money, money, money. You talk to them, and they say it brings jobs. But I got friends in construction, and they are all laid off. How many families I know who have left Kona and moved away, because they cannot make a living.

Mr. Kunewa commented on the ongoing development in Kailua-Kona and throughout the state.

> No matter where development is happening, we need to go back to what is *pono*. These developments, they know if they don't do it right, they are going to pay for it. We are trying to survive and keep what is *pono*. Once it is gone, it is *pau*, and you will never know Kona. We all grew up in this area. We are the last generation, that generation that experienced what the *kūpuna* have left. To pass it to the next generation, that's what we're doing. But they're not going to experience it, because it is gone...I'm 54, and I grew up experiencing what is abundant. The *limu kohu* down the side of the cliff, the fish dancing all around you, and seeing the black crabs crawling all over, like a lava flow...I'd rather look at barren rock, than houses.

6.1.2 Uncle Karin Haleamau

CSH conducted an interview with retired *paniolo* Uncle Karin Haleamau on March 20, 2008, and he also participated in a site visit on May 22, 2008. Born in 1940, Mr. Haleamau worked for Hu'ehu'e Ranch from 1958 to 1993. He generously shared his *mana'o* on life as a Hawaiian cowboy. Mr. Haleamau is familiar with the trails of the project area and ranching history for both Hu'ehu'e and Palani Ranch. At 68 years old, he keeps fit by continuing to run cattle he owns as well as staying active in the community.

Mr. Haleamau grew up as a child in the 1940s, and when he was seven years old, he took a historic trip with his father on the last steamboat of Hawai'i. He is the third generation to work as a *paniolo*. His grandfather was also a cowboy, and so was his dad. In effect, Hu'ehu'e belongs to him, to his father, and grandfather as they all worked on the ranch. Ranches regularly reached out to the community in the form of parades and other events. They were an integral part of the community.

Life as a *paniolo* was hard, but also fun. As he recalls it, *paniolo* at the time did everything to make the land "go," not just taking care of the cattle. A typical work week was eight hours a day, sometimes 10 hours, six days a week. On Sundays, he would go to church, and then work. He got paid $170 a month. Each day, they would start work at 7 a.m.

> In the olden days, we did everything to make the land go. We fixed fences, ran cattle etc. Only four of us worked the land," said Mr. Haleamau. "We never grumbled, because when we needed help, the ranch gave help. When you are working for the ranch, you either survive or don't work at all because it was a rough life.

Although Hu'ehu'e Ranch was considerably bigger than Palani Ranch, the latter had more *paniolo* to care for its land and cattle. "Palani Ranch really took care of its land, they did manual work, cleared the land by hand. They had 8-10 guys, and it's a smaller ranch," he said.

Working at the ranch taught him how to appreciate the *'āina*, the abundant resources, and the rewards of hard work. "The ranch was very important to us—we can farm on the land, fish and hunt. There was enough for us," he remembered. "We didn't have to take for tomorrow. My dad told us, just take what you need." Mr. Haleamau noted that there were no luxuries, and

transportation was limited to horseback riding, or walking. Nature often determined the work, such as battling a huge fire in 1978, when a lightning storm touched off a fire which burned several thousand acres.

Mr. Haleamau is married to his wife Patricia for 45 years, and they have four children: Gary, Kalei, Kevin, and Conrad. They have seven grandchildren. Mr. Haleamau feels it is significant to share his lifestyle and experience as a *paniolo* to all of them.

> I tell my kids you have to learn what the land is about. I'm so concerned about the *'āina*. God gave us the land for one reason, to use it and to share it. I try to do this for the young generation.

Regarding the quality of the cattle, Mr. Haleamau reminisced about the strength and beauty of the *pipi*. One cow can weigh over 700 pounds, with horns ranging from two to three feet. "The Hereford and dairy cattle can handle going over the *'a'ā* (stony lava), beautiful cattle, they were strong...It was important to have a strong horse," he said. Once over the lava, the cows would refresh themselves by drinking the brackish water at the coast, which is high in minerals and good for the cows.

Due to the hot and challenging landscape of the *mauka* Kaloko and Kohanaiki Ahupua'a, water was an extremely precious resource. Mr. Haleamau is aware of only one cave for water collection, although he had heard of other caves that were also used to gather water drops that dripped into calabashes placed on the floor. He did not have to drink water from caves, as the ranch had its own well. "Water was so important here, we didn't waste water. It was so important to cattle."

Mr. Haleamau also discussed caves that held burials. He emphasized the importance of respecting burials and to ask permission from the *iwi kūpuna* if the need to enter the cave arises. He warned that people who do not ask for permission can fall sick if they disrespect the burials.

There are three trails in the project area that he is most familiar with, especially one that he calls "*Uluwini nui*," a secret trail. He describes the start of this trail as being close to a burial. All three trails he is aware of began *mauka* and close together before branching out, depending on their use. One trail led *makai*, so that one can access the sea while the other trails led to neighboring *ahupua'a* like Honokōhau. He believes old Hawaiians made the roads in order to gather such resources as fish. "Maybe this is what trails are for, for those who lived here," he said. Mr. Haleamau is saddened and upset because a lot of trails have been destroyed. "What I'm telling now, it's a dying thing. I'm the only one that can tell you...why are they destroying our land?"

While working the *'āina*, Mr. Haleamau grew familiar with the plants and crops that were available for use and consumption. For example, he used sisal (*Agave potatorum*) for rope. Fruit and plants in and around the project area included avocado, breadfruit, coffee trees, mangoes, Hawaiian lemon, navel oranges, purple *liliko'i* (*Passiflora edulis*) and banana *poka* (*Passiflora* spp.).

When asked if he observed any traditional practices, Mr. Haleamau noted the presence of numerous small pens, where goats were raised by old Hawaiians. But because he was always busy with ranching, he was not able to do anything but his work. "Once you get on a horse, *brah*, you get that cow, and you lose it," he laughed.

For him, the main area of concern regarding the proposed development is the preservation of holding corrals, known as *puakini*. "I would like them to preserve it, so we could show the people...This is very important. This is the one I'm concerned about," he stressed. "I feel this place and the old people who worked there. I feel *aloha* for that place. If they destroy it, they cannot build it again."

Speaking about the difference between the old *paniolo* life and the cowboy life today, Mr. Haleamau said:

> Ours was the way to survive, not to compete...we help others, that's what we did [with] our time. It wasn't a challenge; [it was] more of a responsibility and a life, but today it's so different. I can't be like that. I've seen a lot of good cowboys but also bad cowboys. They tested your skills. They would test you with a horse that can buck you. I had to show the *kūpuna* the habits they taught me, the hard way. Until today, I'm still learning. To me, we are all learning. Every day is a new thing, we learn.

Because Mr. Haleamau shared his memories of working on the ranch, his thoughts also turned to the people who crossed his path and influenced him in many ways.

> I walked with them, and I want to acknowledge them. If I miss anyone, please excuse me. I would like to acknowledge them. These men started the ranch and they made us who we are. The old *paniolo* days, they make sure everybody is *pono*, have *kaukau*...
>
> During my time of work at Hu'ehu'e, around October 1958 or 1959, I was part-time at the ranch that was run by Ed Johnson, who was manager at that time. There was another manager by the name of Roger Williams. After that, we had Dennis Hasarat, and our former and last manager was Carl Carlson. This is my time of work. Before these managers came in, I would like to acknowledge the people I worked with, including Uncle Kino George Kahananui, Jack Kau'i Ha'o, John Kapehe, John Apela Sr., Eddie Kalaū, Richard K. Punihaole, Carl Hose, Louis Kipano, Thomas K. Lindsey Jr., Gilbert Louwando, Clyde Bulū, my brother Herman K. Haleamau, Henry Ha'o Jr., Joe B. Keka Sr., mechanic Peter Cantor Sr., pasture herdsman Herbert Kono, Henry Sereon Sr., Simeon Tina Jr., William Gomes Sr., Kazui Matsumoto, Clifford Medeiros Sr. and Pek'e Bob Manuel Sr. They are all *paniolo* and employees of Hu'ehu'e Ranch before my time and after, who taught me most about the cattle and cultural work, how to live together and survive.

Mr. Haleamau recalled his childhood days when as a six-year-old, his father would take him riding horseback at night. As the horses slowly trotted up and down trails along Kohanaiki, his father would play music and both would drink in the soft sights and sounds of the night around them.

> My father always said take care of the land, it is not ours to fight, not ours to take, it's ours to be...it is for everyone. I want this to be *pono*, for every piece of land. I still remember the old Hawaiians when I used to ride with my father—their house

> was always open. The first thing you see is *kaukau*, and there are no signs telling you that you are trespassing.

He emphasized his need to share his *mo'olelo* about his *paniolo* life and experiences and the knowledge he gained working with people, animals and the land. It is knowledge that can inspire people to take care of the land.

> If I don't share it with you now, it will never be spoken anymore by anyone who has more experience than I have had, in this *'āina* of ours. Now is the time to share with the next generation; there's a lot of memories that I have. If they could feel the *mana*, and *mana'o* of what is true, then they could *mālama* the *'āina*. The *'āina* is going to be here forever more. I love this land. And don't forget to *mahalo* a Ke Akua [i.e., to thank God]. He loves us. That's what it is about...

I want to acknowledge whatever goes on now, and not to feel sorry later on, because this is for the next generation to be preserved. And I want everybody to understand that what we are doing is for all of us. And pls. support the whole community and let's do the right thing now.

6.1.3 Uncle Arthur Mahi

CSH interviewed former *paniolo* and pureblood Native Hawaiian culture practitioner Uncle Arthur Mahi on March 20, 2008. Mr. Mahi's *'ohana* lived in Kohanaiki. He worked for Hu'ehu'e Ranch in the 1930s to 1946, when he enlisted in the army. He was stationed in Korea, Lebanon, Philippines and Vietnam, among other places, and was a member of the military police. Married to his wife Theresa for 55 years, Mr. Mahi has 18 *hanai* children, including his own. He is knowledgeable about traditional fishing, trails, vegetation and other cultural resources and practices in and around the project area, particularly the middle section to the *mauka* portion of the proposed development.

Mr. Mahi is extremely concerned that the proposed development may negatively impact the *'āina*. He questions why trees such as the *wiliwili* (*Erythrina sandwicensis*) are dying, noting there are no more mango trees or native trees like *alahe'e* (*Canthium odoratum*) in the project area. During the 1930s to 1940s, these trees flourished in the project area and the surrounding land. Plants like banana, *uhi* or yam (*Dioscorea alata*), and *pia*, a Polynesian arrowroot (*Tacca leontopetaloides*) used as medicine and food by Hawaiians, were also widely distributed. "All kinds of plants were present, until these were choked by the bushes," said Mr. Mahi.

According to him, such plants were integral to Hawaiians not only for their use as a food and medicine resource but also for their connection to other aspects of life. For example, he cites a Hawaiian proverb that when the *alahe'e* tree blossoms, the *he'e* (squid, octopus) are *momona* (fat) and ready to harvest. Another saying involves the *lākana* (*Lantana camara*); when this plant blossoms, the *hā'uke'uke* (*Colobocentrotus atratus*), an edible variety of sea urchin, are also *momona*. If while harvesting the urchin, one was stung by the spikes of the *hā'uke'uke*, lemon or vinegar could be used to neutralize its sting.

Mr. Mahi remains steadfast in his insistence that plants must be respected. People need to be aware of giving back to the *'āina* whenever harvesting them. "When you plant, the plant is not just for you, but for everything and everyone," he said. "Everything that grows in the culture, you respect them. If you don't take care of them, they die." For Hawaiians, there is no such thing

as one "earth day" once a year; rather, it is every single day. "Our earth day is every day," Mr. Mahi noted. "You take care of the *'āina* and the *'āina* will take care of you."

This belief goes hand-in-hand with his conviction that no one can really own the land. "When people buy the land, you only buy the use of the land," he said. "Who owns the land? Ke Akua (God) and grandparents...When you die, you can't take the land with you. You don't own the land, the land owns you. What belongs to Hawai'i, belongs to Hawai'i."

As far as Mr. Mahi is concerned, "the *iwi* own the place." He recounted the traditional practice of Hawaiians burying their loved ones in the lava tubes or caves around the project area. Since there were hardly, if any, cemeteries before, Hawaiians used the places where they lived. They wrapped their loved ones with a *tapa* cloth and placed them in lava tubes or caves.

Caves were also used for other purposes, such as water collection. It was sometimes the case that water was collected in caves where *iwi* would also be present. Hence, Mr. Mahi stated that one must always ask permission from the *iwi*, before collecting the water. "You always say *mahalo* when entering, *aloha*, and *mahalo* when leaving." He frequently utilized the water collection in caves, noting that some water drips were fast, and some were slow. He brought his own calabash to collect the water, which tasted like "regular water."

Besides collecting water in caves, Mr. Mahi recounted diving in the deep sea with a gallon jug to collect water from the fresh water springs in the ocean, during the 1970s. Rain was also used for water. He also drank brackish water from the anchialine ponds in Kaloko and Honokōhau. "We got water all over the coast," said Mr. Mahi. He added that a *limu* (algae, seaweed), or moss was squeezed as a source of water and was found at the entrance of *ana* (caves).

An avid fisherman, Mr. Mahi shared some of the traditional ways of preserving fish. Using fish like *aku*, bonito or skipjack (*Katsuwonus pelamis*), he preserves them in Hawaiian sea salt, for up to 10 years. The fermentation yields a liquid condiment similar to *bagoong*, a Filipino fermented shrimp/fish condiment.

Besides the negative impact on plants, Mr. Mahi is concerned about the price of homes as well as the preservation of trails. When told that the price of homes may vary from an estimated $200,000 up to a million, he expressed doubts that the homes would really be affordable and wondered what kind of house it would be for $200,000. "That's not affordable houses, that's hanging our neck," he said.

According to Mr. Mahi, there are plenty of trails, *mauka-makai*, in the project area. He underscored the importance of preserving the trails. "Don't build houses on the trails," he warned. "Spirits are going to come, donkeys, people on the trail, through the house."

Mr. Mahi told of stories of people who complained about spirits that continue to pass through their house, as if they were still walking on a trail. He also advised against moving *iwi*, saying "Don't move the burials, because the artifacts are theirs."

Through his lifestyle, cultural practices and beliefs, Mr. Mahi expressed the value and the need to respect the Hawaiian worldview, where nature and people are interconnected and mingle with the past, present and future. "Everything you do is not for you. It is for the future, for the grandchildren, great-grandchildren etc. If you don't know now, it's too late."

6.1.4 Mr. Peter Keka

CSH interviewed Mr. Peter Keka on March 21, 2008, at the Kaloko- Honōkahau National Historical Park. Mr. Keka's *'ohana* has lived on Honōkahau for many years, and they also leased the fishponds in both Kaloko and Honōkahau. He grew up learning about the traditional ways to maintain and manage the enormous ponds, and is currently employed to restore the fishponds as well as other ancient Hawaiian sites in the park. Mr. Keka was born in 1940, and is 68 years old.

In response to the question if he has any concerns about the proposed development, Mr. Keka said:

> Let them come. Let them destroy it. Then they'll know what they did. You won't be able to stop it. You can slow it down but you can't stop it. Because greed is in everybody's blood...That's what's nature is about. It's people. To try is one thing, to stop it, is another. If you look at it, one is to be satisfied with what is, and the other is...(to be) in contempt.

Mr. Keka remembers vividly when his grandfather passed away 56 years ago. As a young boy, he was warned by his grandfather that change was coming. "It will destroy everything," Mr. Keka said, describing his grandfather's words. "I didn't know what he was talking about. Now I know. It's everybody, but look carefully. It's how you control things. You have development all over the place. You won't be able to stop it. No matter how you try, you can't stop it."

6.1.5 Mrs. Cynthia Nazara

CSH consulted Mrs. Nazara in person about the proposed development in Kohanaiki and Kaloko Ahupua'a on March 24, 2008. Mrs. Nazara's *'ohana* is from the project area and surrounding *ahupua'a*. Her great-great grandfather, William Keanaaina, was the caretaker of Kaloko pond. Her mother, Malaea Keanaaina, was born in Honokōhau junction, while her grandparents are from O'oma. Mrs. Nazara serves on the Hawai'i Island Burial Council and is an active member of the Kona Hawaiian Civic Club. She was born on O'ahu in 1947, and moved to Hawai'i when she was 13. She is the oldest of 10 siblings, and is the first cousin of Ruby McDonald.

Mrs. Nazara spoke of her extensive experience working as a cultural consultant to ensure that developments would not stray from what was promised to the community. In 1993, she worked on Four Seasons Hualālai.

> It was very different from what they promised. The first five years I was involved, it was low impact. And they always said they would build affordable. But to whom? They set it up so that they would build and it won't be seen from the road, but now you can see it from the road.

Although the experience made her wary of development, Mrs. Nazara believes that it is possible for cultural and lineal descendants to work with the developer.

> For me, I am never against progress. Progress is good. But people are angry because big companies come in and exploit us. They promise things, but when you look at the project, it's not the same. We want as a people to make sure the

> developer does what he wants to do, but we cannot help them if he doesn't tell us the truth.

According to Mrs. Nazara, developers in general are out to make money, and it is the responsibility of the descendants to be involved.

> Here in Hawai'i, whether we like it or not, developers are going to come in. As *keiki o ka 'āina* [children of the land], we want to be able to come to the table with these developers to ensure that things will be done right. And that's what everybody should strive for. There have been too many people living here that have been exploited. Developers come and suck all the "*hā*" out, all our breath and knowledge, and then they throw us out. We have to let people know. If we can get our foot in the door and work together with the developer, that's a good thing. Our goal is to not stir things up, but to work together. Don't exploit us.

6.1.6 Mr. Duane Keanaaina

CSH interviewed Mr. Keanaaina on March 26, 2008. Born in Kalaoa Kona, Hawai'i in 1952, Mr. Keanaaina's *'ohana* is from Kohanaiki as well as neighboring O'oma, Kalaoa, Ho'ona, Mahai'ula, Makalawena and Pu'uanahulu. The Keanaainas spent a lot of time in Kohanaiki *makai*. They also traversed the project area hunting feral goats, pigs, and gathered seasonal fruit. He mentioned that there were several trails traversing the project area. Additional information on the trails can be obtained from the Hao and Lee *'ohana*.

For Mr. Keanaaina, the size of the proposed development is not the question, but how it is developed. His main issues of concern focus on the areas of safety and ensuring the development is people-friendly:

> Development is inevitable, but how you do it, that's the question. If it is just high density, nobody wants that. But if it's community-friendly, you won't have too much opposition. Don't jam the lots too small, make it open so it's comfortable to walk around. If they are building a community, make it as safe as possible.

According to Mr. Keanaaina, the development should have careful landscaping:

> Landscaping is the key of the whole thing. You can soften the development if you have a bunch of houses, if trees are planted around it. If you use different types of landscaping, you can soften the visual impact for the neighbors above them…any opposition would come from neighbors above them.

In addition, he called attention to a section on the project area made up of a lowland forest. He also noted that although there are not too many endangered plants in the project area, there is at least one native plant called "*ko'oko'olau*" (*Bidens* spp.). When dried, it is taken as a tea or used medicinally as a tonic. It is often preferred over store-bought tea because of its pleasant taste. He suggested that the seeds of the plant should be collected and later re-planted as part of the landscaping:

> The *ko'oko'olau* plant is in the project area. The only place you'll find the plant. If they will develop it, please get the seeds, and use it as part of the landscaping when doing it. The plant is used for tea, better than Lipton and Earl Grey. You

> have to watch for this plant, because this is the only area that has it and collect the seeds.

The following is a list expanding Mr. Keanaaina's concerns and questions:

1. Children can get hurt if the multifamily complex is across the street from a shopping center and convenience stores. Consider installing an underground tunnel for ease and safe pedestrian access.
2. Regarding project density, sidewalk has to be no less than 4 feet, even wider if possible. This is because there are more people walking in the morning and the evening. "If you make it neighborhood friendly, are they going to install a walking trail that would allow them to go around the area and back to their residence?" he asked.
3. Pointing out that the development will be right next to a busy and steep road going uphill, Mr. Keanaaina suggests the inclusion of a runaway truck ramp. With all the heavy equipment on trucks going uphill, the ramp could keep people safe in case brakes fail.
4. No master plan has been provided for review and consideration.
5. Does the developer plan to build a shopping center or market?
6. On what side of Hina Lani Street will the multiple housing project be built, north or south? How many stories will the multiple family housing have?
7. Will the developer construct a highway to Kealakehe school, to help with traffic problems on Queen Ka'ahumanu Highway?
8. Are open areas being considered, such as a community center, parks, walking paths, soccer and baseball fields?
9. How will the community traverse Hina Lani Street, overpass or underground tunnel?
10. Does the developer plan to keep the lowland forest within the project area?

As mentioned above, the *ko'oko'olau* plant used medicinally as a tonic or dried and drank as a tea is found within the project area. But there are other native plants, some endangered, which also thrive within the project area. Seeds from these plants should be collected and replanted within the project area as part of the landscape design plan.

Mr. Keanaaina also made referrals to several individuals, including Kelly Greenwell whose family operated a cattle ranch in the *ahupua'a*. Clarence Rapoza now operates Palani Ranch and may have information on the proposed project.

6.1.7 Uncle Valentine K. Ako

CSH interviewed Mr. Valentine K. Ako on Mar. 27, 2008. Mr. Ako was born in 1926 in Hōlualoa. He comes from a long line of family that has resided in North Kona for generations. As a young boy, he learned from *kūpuna* how to fish and gather salt, as well as other vital Hawaiian traditions. At 17, he enlisted in the Merchant Marine and travelled around the world for eight years, during a period he calls "some of the best years of my life." He is knowledgeable

about the fishing practices and resources up and down the coast of Kona, and about the people who lived in the project area and beyond.

When asked about his concerns regarding the proposed project, Mr. Ako said: "That's a big area." He mentioned several trails in Kohanaiki, with some trails taken by *kūpuna* in order to go fishing. Mr. Ako also confirmed the presence of burials in lava tubes in the project area, saying:

> During the old days, prior to Westerners coming over, our *kūpuna* buried their loved ones in the lava tubes in that particular area. As generations went by, they didn't notify the heirs where their loved ones are buried. My dad before he passed away, took me up Palani and Māmalahoa, it was just barren at that time, so you could see down to Kohanaiki. And he said, "Our ancestors are buried there, these are all our ancestors buried there."

He expressed strong feelings against the removal of any of the burials that may be found during the course of development.

> My concern is this: Do not relocate these ancestors to another *ahupua'a*. If you find these graves, do not make it so that people can find them. This is where all our Hawaiian ancestors are buried. Leave the lava tubes alone, and seal it up. Don't make it so that people can come and see the graves and desecrate them. It's so important for developers to realize where our ancestors lived. You have to tell developers that this issue is important to us. My ancestors are all from this area. When they find these lava tubes, seal it up and do not expose it. Do not relocate them to another *ahupua'a*.

Besides lava tubes, cinder hills were easiest place to bury the *kūpuna*, because there were no metal implements. An *'ō'ō* (digging stick) was used in sandy beaches, but most of the time, Hawaiians dug by hand. Mr. Ako warned that it is when graves are moved or disturbed that the tribulation begins.

> When people come from all over the parts of the world and they have different ideas and no respect for our ancestors, and they try to implant their lifestyle, that's when trouble starts. As an elderly person today, we should make it a point to respect our *kūpuna*'s burials.

He stressed the importance of listening to *kūpuna* and their words to learn about the rich history and culture of Hawai'i. From 1992 to 2000, Mr. Ako worked with Kepā Maly to helped locate *kūpuna* around 80 years or older in order to record their knowledge. The interviews span North Kona history from Kohanaiki and other *ahupua'a* up to Kawaihae, and are stored with the Kona Historical Society. He also recommended two works in particular that would assist in appreciation and understanding of Hawaiian culture. One is a book by Mona Kahele, *Clouds of Memories*. The other is a book featuring maps and trails of the *ahupua'a* of Hawai'i, by Walter E. Wall, Dec. 1928 edition.

Mr. Ako shared some interesting insights into preserving fish and making fish sauce. For example, he takes *'ōpelu*, adds a lot of salt, and then mixes it in a blender. He then puts the salted fish pieces in a dish with a towel over it, leaving it under the hot sun for two months. After it becomes grey, he strains the liquid and uses it for cooking as well as the fish. He also discussed the different kinds of *poi*. Not everyone was allowed to mix *poi*, as one's body

chemicals could turn it sour or sweet. "Our *kūpuna* were conscious of who made the *poi*," he said. "The same goes for turtle meat. If you have lousy hands, the meat will turn bad."

6.1.8 Kahu Norman Keanaaina

Cultural Surveys Hawai'i interviewed Rev. Keanaaina by phone on April 9, 2008. He comes from a family of 14 children and was born in Kona on Nov. 4, 1940. Rev. Keanaaina's *ohana* has lived in the lands of Kaloko and Kohanaiki, as well Honokōhau and Kalaoa, for generations. Rev. Keanaaina's great-great grandfather Kea'naina, or Kea'naaina Nuuanu, is buried at the Kohanaiki point. According to the reverend, Kohanaiki is also known as Kohaneiki and Kahaneiiki.

When asked what he thinks of the proposed project, Rev. Keanaaina said:

> The project is not in Kohanaiki, I've seen the deed, it is for Kohana'iki, which is located in the *ahupua'a* of Honokōhau-iki. My grandfather owned all of this, Kohanaiki. Kohanaiki is still with the Kingdom of Hawai'i. Kohana'iki is noted as a nudist area, while Kohanaiki is a place of discipline.

Rev. Keanaaina feels very strongly against the proposed development, stating several times that the deed is not for the proposed area. He maintains he has filed a notice at the Bureau of Conveyances on O'ahu and at the Recordation office of the Aupuni Hawaii, an organization which seeks recognition for the Kingdom of Hawai'i. Rev. Keanaaina also states that notices have already been served to the developers of Kohanaiki over a year ago.

He cautions against what he called "lies and false filing."

> ....They said my grandpa was just an agent. No, my grandpa has the deed and now I have it. Mayor Kim and Angel Pilago is another problem. When they found out what was happening in Kohanaiki (*makai* of the project area), they ran away. I'm not blaming the developers, rather, I'm blaming them. And Linda Lingle. They're the cause of all this, the problems of Kohanaiki. They're playing a political game. But...they should stop and listen.

Rev. Keanaaina also discussed his plans of constructing a center to bring together various cultures present in Hawai'i. He would want to construct the center on the *ahupua'a* of Kohanaiki.

> I have plans for an international cultural center, because in Hawai'i, there are a lot of cultures today. In order to please everybody, we are going to have this center. There are 190 nations that I have contacted to bring their culture to Hawai'i. They are a part of my family, because of so many intermarriages.

6.1.9 Mr. George Van Gieson

CSH interviewed Mr. Van Gieson by telephone on April 28, 2008. Mr. Van Gieson is the Fire Captain of the Volcano Fire Station, and was active in helping preserve the *hōlua* or slides around Hawai'i. In 1976, he was one of the members of the non-profit Hōlua Project Information whose mission was to record and safeguard *hōlua*. Mr. Van Gieson stated that all of the slides the organization found were on the Makahiki trail, which goes around the coastline of the island.

When asked if he is aware of any slides in the project area, Mr. Van Gieson mentioned the *hōlua* in the Kaloko-Honokōhau national park.

> That one has always been a mystery to us, because it's so short and only 300 ft. long. And also it's really, really wide. The other thing is, that might have been to move logs down for canoes. It has the classic shape of a *hōlua* but it's so short and wide. But some people say it might have been a practice *hōlua* as several people can fit in it.

Another issue about the *hōlua* is that, between it and the highway, there are a lot of burials found, according to Mr. Van Gieson. His father had been with a select group of people who had seen a cave filled with many *iwi* that is located *mauka* of the *hōlua*. It is believed that they are the remains of hundreds who died in a flu epidemic which swept the island sometime in the mid-to-late nineteenth century.

6.1.10 Kumu Larry Ursua

CSH interviewed Kumu Larry Ursua on April 15, 2008. He is a Hawaiian cultural practitioner and an active community participant. Married to his wife Laurie for many years, Mr. Ursua is a 48-year-old father of six children. He works as a Father Coach at the West Hawai'i Family Support Services. Trained by the highly respected John Kaimikaua who was his mentor and teacher, Mr. Ursua continues to teach *kāne hula* (men's hula) in West Hawai'i and also previously taught Hawaiian Language and Culture as part of the community college.

When asked if he knew of any specific cultural practices and resources in Kohanaiki and Kaloko Ahupua'a, Mr. Ursua stated that he is not versed in the *mo'olelo* and referred to two individuals in particular, Mahealani Pai and Uncle Black Ho'ohuli, who are descendants from the Kohanaiki Ahupua'a. He said simply, "this is not my *kua 'āina*" (countryside).

Mr. Ursua shared his particular concern about the proposed project by expressing a wide-ranging prophecy from the ninth century that was taught to him by the *kūpuna*. Called the *Wānana*, (lit. "prophecy"), it foretells the consequences that happen when land is used for one's personal gain and how it is of the utmost importance to give back and respect its resources.

> I know that our ancestors began with a prophecy. The prophecy is called *Wānana*. The prophecy was the inevitable would come, that the land would be inhabited by many natives and people. The *Wānana* also said we would lose the ideas, religious and beliefs of our culture and we would struggle with a western lifestyle but later with time, we will adapt to it. This is the *Wānana* that I share...
>
> The *Wānana* concerns the forthcoming of a new age of life of the people of Hawai'i. These people that will come, will come from many nations trying to utilize the lands and to gain their own personal and their own nations' gain. The *Wānana* was spoken by the prophets, the prophets of old, going back all the way to the time of the ninth century. This *Wānana* was not only spoken on each island but was spoken by powerful prophets, leaders and *kahunas*. Like Kohanaiki, it is another land being developed. Like the prophecy, it entails the using, producing and manufacturing of lands, to serve not those *koko* to the *'a'ina*, *koko* as in bloodline to the *'a'ina*, but those from the outside. This prophecy helps us to

> understand that when these things occur, either we will stand as a nation of people that are raised from the sands of Hawai'i or we will stand separate. It spoke even about the lessons, tribulations that will be brought about by new generations of Hawaiians which would become aware of how important the western education would be in being able to utilize their system and law and government because the land would be taken.
>
> The land was taken and it was genocide. Later in 1993, an apology was made to the people of Hawai'i for the genocide of the islands and the Kingdom of Hawai'i. That separating many Hawaiians to stand for the reasons they stand today, creating many types of programs and other types of governments. At least small governments that help them to stand and build more Hawaiians to come to help them in their endeavors, to regain their kingdom, regain their government and regain their land. That would all fail. That would all fail because of the small uniqueness of the land and its people, now divided in this 21st century.
>
> So the *Wānana* as we were talking about...to better understand why Hawaiians will have difficulties coming together from families, from different districts concerning Kohanaiki. Kohanaiki in their first motion to do what they needed to do, affected Hawaiians, a very small (number) of families, to step forth in protecting and giving voice to that land...

Mr. Ursua discussed his belief that development is "inevitable," but what is essential is to work together with developers to ensure that the land is protected. He mentioned the Kohanaiki *makai* development that involved community members, including him, to assist in conducting the proper protocols in taking care of the cultural resources that were found on the land.

> However, the *Wānana* says that no matter what, the inevitable would be the land would have development and would be used for some gain and goals for other developers to come unto the land. As a person, as a Hawaiian myself, looking at the land and watching it being developed, I realize the prophecy is coming to pass; that this place must be built like many places from the past. And they are built out of different types of minerals, resources and structure. Our land will be built out of other things not from this land. Our ancestors will not be able to recognize the structure and building but they are also aware of it even though they are behind the veil and have passed on from this life. They have an idea and it echoes in their ears that the prophecy, the inevitable, would come. These things can be of great benefit to the people of Hawai'i, and these things can be a great downfall to many people who tried to look at opposition and looked at it as conflict.
>
> This is the inevitable, things will be built on the land, but as developers come, if we can gain their support, gain their trust, we can work civilly towards protecting the land still and providing the land with what it needs. The culture of Hawai'i is an important part of our children and those who come to learn the culture of Hawai'i. With that, we need to provide the kind of guidance for our generation to come so that they will be able to act accordingly, properly, in a way that they can meet certain things and communicate well with the developers. Rutledge came in

> and they allowed a team to investigate one of the caves that was breached and I was one of those members who were part of the team. That in itself says that some developers will want to be culturally sensitive to things that are culturally here. And that would be a great step as business and developers come to the land. That cultural consultants and people who have sentiment to the land communicate and work together with them to provide proper burial sites and proper protocols for where certain parts of the land were sacred in the past, sacred now, and will be sacred in the future. This is the Wānana that was spoken. Many things will fall, the sky, the heavens, the sun, the stars, the moon. The heavens will fall, and all that shall be left is the *maka'āinana*, which is the common people. *Maka* the eyes, *nana* is to watch. The watchers and keepers of the land. And I am one of them, hoping that the land would produce properly for the future.
>
> This was the *Wānana*. It is now, it is happening. This is the present time...

For Mr. Ursua, at the heart of any development of the land is the proper or *pono* way that one must approach it. He believes that to conduct oneself with arrogance and self-centeredness at the cost of gouging others and resources of the land is setting up one's self for later punishment.

> This is just my personal *mana'o*. If I preach this to many, they would follow. They would want to follow what their ancestors said. I don't preach this enough, but if I did, I think more people will have respect for peoples of the past and the generations unborn. If we all remain sensitive as people in general, not just Hawaiians, the land will be welcoming to all kinds of people whether you build your home here or not. But when we come for self-gain and self glorification, whatever you build on the foundation of the land, Hawaiians know in the past, our ancestors, (that) the land is alive. It is the mother and the womb of the Hawaiian people and if our mouth, our lips, and our voice as Hawaiians is not heard, not just any Hawaiian voice, but a voice of a Hawaiian person who is *pono*, submissive, humble, the mouth of Mother Earth will consume developers, and all those who build on her land for self gain. It may not happen tomorrow or next year, but she will consume it on her own time. Tūtū Pele is awake and her breath, the volcanic vog is an indication as she covers the state of Hawai'i to remind all her fires have no boundaries. That she will creep into any crack or crevice even onto developers' land and turn any haughty or self-gained development into ash. These are the words spoken from our prophets.

Discussing the contemporary events such as the high rise in gas prices, the sudden end of long-term airlines such as Aloha Airlines, and the cost of war, Mr. Ursua links all these events as part of the prophecy and illuminates what it means for the future of Hawai'i if people do not change how they live.

> We are in a depression mode, because we cannot build Aloha Airlines and ATA airlines. It can't be realized because of billions of billions of dollars are spent to conduct peace, but at the price of human life. Very shortly, for Hawaiians and all kinds of people, the crime rates will soar because people don't have jobs...

> We live on four major islands of Hawai'i and we live right smack in the middle of the Pacific. Our islands will not be on the priority list for products to be brought here. Because of what is important, crude oil, all things are run by those particular minerals. So we are heavily stocked by shipment, not be airway. Already the airways are shutting down. The airways that we fly to and from will be so expensive that it will be actually a luxury to travel and see family members. Now they will open the waterways, and it's still the same kind of product that we run our planes with, fuel. It has to cut across the ocean but those things will be cut off. Not only that, all of the products that come to Hawai'i will be cut off...

According to Mr. Ursua, caring for the land and turning back to the traditional methods of giving to it, not just taking from it, can help Hawai'i survive the steep costs of being dependent on oil. Those with the knowledge of caring for the land will suddenly be the most integral in a chaotic world where wars are caused over oil. Hand-in-hand with taking care of the land is the essential need to turn back to God or Ke Akua and to be mindful of the evils caused by greed and selfishness.

> A dependent land has to become independent and their people on it and Hawai'i will be challenge by that. With independence, you can do as you need but it will be how we have taken care of the land. Now we will have to go back to the very basic things our people did, to care for the land, to plant on the land, to fish on the land, all those practices will come back into play, and we will see how the land and the ocean will respond. And the resources of these things that were once in the land have already vanished. The land will be in chaos, the people will be confused. The *pono* within them will be lost. It will become a dog-eat-dog world.
>
> But there will be a few that will have power. Not just to suggest or to speak words, but the power to bring together the very few who are called "*Hoale Kalepopolo*." These are the kinds of people who come from the fields, from the mudflats, from the ocean. They will not be filled with education; they will be filled with understanding and the spirit of the land. And to those few, the land will yield. Bananas will grow, taros shall foot forth from its waters, the mountain will flourish for them and they will provide a "*pu'uhonua*" for the modern-day families. *Pu'uhonua* are used as a safe zone for those who broke the laws of the land. But the modern day *pu'uhonua* will be a person, will be a group of people who shall have wisdom, they shall have knowledge, they will be one with the land and the heavens. When they *pule* and pray and command the land to yield forth its fruits, the heavens will be one with them and the land will produce. People will understand that all we have today that technology can provide, it will be the spiritual foundation of the people of Hawai'i and the land to promote and provide the things that will care for the people here. And they will turn back to their past and turn back to their *kūpuna* and they will become a prayerful people, a submissive people, and Ke Akua will look upon that and we pray that He might be merciful. That in His response, we can start to rebuild the kind of heaven that is needed on earth. This is only a piece, a short version of the *Wānana*.

These things actually continue to exist, but if we continue to build, to develop down the coastline thinking that it is a good type of building and a good type of selling, then think about where you are building and where you are selling. You are not selling just any land, you are selling a land where people believe and live to know that the land itself is alive with spirit. And that spirit, that *'uhane* of the land, when you drive pillars, when you drive wood, when you drive metal to her and she is not willing to receive it. Many lands have to be blessed and consecrated by *kahus*, and sometimes not just the whole project, but in the project if there is 50 feet or if there is 47 acres, one prayer would not encompass the entire 47 acres, because what you blessed the land to take place for that moment, it might have changed on the blueprint of what they were going to do in a particular location of the property which was not part of the deal. When you changed that, the *pule*, or the blessing is voided. Therefore it re-opens itself to all kinds of things. And just be mindful that like any child, or any person, when we need to be reprimanded, we first get a warning. And our little warning was a 6.3 earthquake recently. That is just a shake, and now we are going into a rattle. Now the rattle is, although we don't say much, we are rattled by the vapors that when we look on the land, we can see the vapors, the *hā*, or the breath of Pele, travelling throughout the land. She is swelling, she is expanding beneath us, and she will make herself known. And there will be no mountains, no hills that you can run or hide from, because every hill and every mountain was created by her and at her command. Four of her mountaintops that lie on the island of Hawai'i are only dormant; they are not dead. She can travel to any of them...I'm not trying to be scary about this but when you tell people stuff like this---

...If we are in the image and likeness of our Creator, and he is looking at us right now, then he is saying "well for some of you, but woe onto many of you who have not been mindful of the things and place that I have given you." Of course, this is not the Garden of Eden anymore, but that place once in the very beginning existed. We left that garden, that we might till and care for the land. But instead, we have ripped and stripped and tore the land. For those who go about with Greenpeace, those who go about preserving the land and caring the ocean, blessed are those who do that because you are caring for the very earth that produces for you. But those who go into the sea, to the mountain and strip it of its resources, and tear it and make things extinct, your time will come. You don't have to die, but you will be afflicted by the things what others feel, you should be able to taste it. If we are the image of our Creator, then we have the potential to become like Him...If we have the opportunity to be like our Father, and have our own work to govern, give our only begotten Son, and watch the world as it produce and the nations and generations produce upon the earth and watch it develop, we are going to know exactly how those people are going to take care it. If we do what we do unto our father's planet, our children would do the same. But how are we going to respond to that? We have so much potential. And that was part of the prophecies of Hawaiians. We are not just a vapor of time; we are not a vapor like the vog you see in the sky that when the winds come, it shall blow away and is no more. We go from our mortality and our existence and our learning, our

probation, our trials and tribulations, our joys and happiness, all of that which our emotion can stand... And then it is followed by immortality. When we are in the immortality stages, and we separate our body from our spirit, we do not not continue to exist, we just exist on a higher plane. And we can look down and help our descendants like our *kūpunas* in the past have helped us. But we need to acknowledge them now more than ever, because they come with a righteous and ancient past, and righteousness that will provide us the wisdom and the strength to carry on in this last dispensation.

This is the last dispensation and our people knew that Lono wasn't just Lono. They knew Lono to be Ke Akua, he was Jesus Christ, and Jesus Christ came here and he taught the consecrated law. How can they bow down to Captain Cook, because he looked like someone they saw before his time? The only description he fits is the description of Jesus Christ, with eyes that are bluish green, fair skin and hair long and brown. And he wore his red robe. Our people were very clear about who that person was, and that person sat and showed them who he was and told them he would come again. And the reason why he's going to come is that he is going to cleanse the earth with his entity. Under the command of his word, Tūtū Pele would burn the land. At the command of his word, he would call his prophets to call upon the ocean to cleanse the lands with its high waves. Upon his words, he will call those who will command the winds that come and strip down everything that stands. What will be left is a pure form of the land itself, and then we will start again and that is what is meant to be. But all that we have, that we take advantage of—I am one of them, I like roads, I like stores, I like this and that---if we don't ration properly, we are going to lose more than what we have. That again goes back to the prophecy. I don't live just by that, but I understand that when it was prophesized 900 years ago, why would they say that about our time? Because they could foresee what people and how greedy people were going to be. And all the simple laws of the land were going to be forgotten, the simplicity of life, the basics of life were going to be put on the back burner and they were going to put up new things and it's not bad. I'm not saying that it's bad, but it is the intent and purposes in how they are using it, that makes it bad.

6.2 OHA Response Letter

In a response letter dated April 24, 2008, the Office of Hawaiian Affairs (OHA) conveyed several specific concerns and requests regarding the proposed project (see Appendix A for the letter). First, OHA requested CSH "conduct a thorough review of all archaeological reports and cultural studies related to the larger area which will be subject to the cultural impact assessment," and "a comprehensive archaeological inventory survey" pursuant to applicable statutes.

Second, OHA requested the opportunity to comment on all significance criteria assigned to historic properties identified during archaeological inventory survey in accordance with HAR 13-13-284-6(c).

Third, OHA raised the issue of consulting with individuals regarding their rights to access the project area "for constitutionally protected traditional and customary purposes."

Fourth, OHA recommended consultation with cultural descendents to burials within the "Kaloko Heights" project area, as recognized by the Hawai'i Island Burial Council, regarding cultural sites and resources that may be present in the subject project area; this consultation should also include community groups such as "Kahu o Kahiko."

Fifth, OHA discussed the cultural significance of the "Road to the Sea" trail, and stressed it should "be preserved in perpetuity," in accordance with applicable statutes and legal decisions protecting traditional and customary practices and the landscapes that support or supported these (in this case, subsistence activities taking place at both the seashore and the uplands).

Finally, OHA requested the opportunity to review the final CIA for this project.

Section 7 Traditional Practices and Properties

Discussions of specific aspects of traditional Hawaiian culture as they may relate to the project area are presented below. This section examines resources and practices identified within the project area in the broader context of the encompassing Kohanaiki and Kaloko Ahupua'a landscape. Excerpts from *kama'āina* interviews are incorporated throughout this section where applicable.

7.1 Hawaiian Habitation and Agriculture

According to the CSH archaeological inventory surveys of the project area (Bell et. al 2008a, b, c; Esh et al. 2008), of the total fifteen (15) habitation sites in the project area, thirteen (13) sites fit the characteristics of temporary habitation and two (2) are categorized as permanent habitation.

The majority of the temporary habitation sites within the project area are located on the *pāhoehoe* flow on the east and southeast side of the project area. Both permanent habitation sites are located on or near the edge of the large *'a'ā* flow that dominates the project area. In terms of elevation, all of the habitation sites are located above approximately 500 ft a.m.s.l., and generally the sites are scattered across the eastern portion of the project area. It is notable that nearly all non-lava tube habitation features are located on a naturally elevated area (either tumuli, outcrops, or *'a'ā* edge).

The terrain throughout the majority of the project area severely limits agricultural productivity, since large portions of the project area are barren *'a'ā* lava or rough *pāhoehoe* with no soil development. However, some of the *pāhoehoe* areas do have soil development, although these tend to be fairly small and shallow everywhere except for the far *mauka* extent of the project area. The agriculture-related features throughout most of the lower elevations of the project area represent more of an opportunistic approach versus the more expansive/intensive approach practiced at higher, more productive elevations.

Despite the lava covered terrain, various crops were traditionally and in historic times cultivated within the project area; and sweet potato is likely to have been the most abundantly grown crop because of its adaptability to stony, dry environments. It was commonly planted in mounds and in *pāhoehoe* excavations. It is notable that the most intensive areas of agricultural modification are located where there are older (highly eroded) *'a'ā* flows, ideal for building planting mounds. Besides sweet potato, gourds, mulberry, and taro are the most likely crops to have been grown in this area. Both taro and sweet potato were named as actual crops during the Land Commission documents for Kaloko lands during the Māhele of 1848.

7.2 Gathering of Plant Resources

In ancient Hawai'i, upland forest regions provided various woods needed for canoes, tools and more, as well as cordage, food and herbs (Abbott 1992). Several of the plants within the project area have past and present ethnobotanical uses for native Hawaiians (e.g., as medicinal, building, weaving). Many of these plants are (possible) Polynesian introductions such as *kukui* (*Aleurites moluccana*), *kī* or *tī* (*Cordyline fruticosa*), and *noni* (*Morinda citrifolia*). Some of

these Hawaiian canoe plants (plants brought by the early Polynesians in their canoes) are indicators of former Hawaiian habitation. For example, *kī* was often planted around *heiau* (temples), and considered a sacred plant in parts of Polynesia. *Kī* was also planted around taro *lo'i* (pondfields) (http://www.canoeplants.com).

A contributor to this cultural assessment mentioned past or ongoing plant gathering of the *ko'oko'olau (Bidens* spp.). Emphasizing that the project area is "the only place you'll find the plant," Mr. Keanaaina discussed the use of the *ko'oko'olau* plant for tea and as a medicinal tonic. Its pleasant taste when dried makes it preferable to "store-bought" teas, according to Mr. Keanaaina. He and several other participants also noted the presence of one of the last remnants of a dry land forest located on the project area. Other plants present in the project area include the native *pili* grass (*Heteropogon contortus*), *'ōhi'a* trees (*Metrosideros polymorpha*), *laua'e* ferns (*Phymatosorus scolopendria*), *'ohe* trees (*Reynoldsia sandwicensis*), *alahe'e* (*Psydrax odorata*), and *halapepe* (*Pleomele* spp.). Native plants observed at higher elevations include: *naio* (*Myoporum sandwicense*), *'a'ali'i* (*Dodonaea sp.*) and *'ulei* (*Osteomeles anthyllidifolia*).

Mr. Mahi specifically names native trees like *alahe'e* (*Canthium odoratum*) in the project area. During the 1930s to 1940s, the *alahe'e* along with mango, banana, *uhi* or yam (*Dioscorea alata*), and *pia*, a Polynesian arrowroot (*Tacca leontopetaloides*) used as medicine and food by Hawaiians, were also widely distributed in the project area. "All kinds of plants were present, until these were choked by the bushes," said Mr. Mahi.

7.3 Marine and Freshwater Resources

Like the integrated system of Hawaiian culture where an individual is linked to the surrounding environment, there is often a connection between marine resources and the agricultural plants found in the project area. For example, Mr. Mahi noted the presence of *alahe'e* trees in the project area and cited a proverb that when the *alahe'e* tree blooms, the *he'e* (squid, octopus) are *momona* and ready to harvest. Another saying involves the *lākana* (Lantana camara); when this plant blossoms, the hā'uke'uke (*Colobocentrotus atratus*), an edible variety of sea urchin, are also *momona*.

Although outside the project area, the Kaloko-Honokōhau fishponds provided Hawaiians with a rich resource for fish and shellfish. The ingenious design of the fishponds allowed fresh water in but prevented large fish from getting out. Besides the extensive aquaculture and tidepools available for shellfish and several types of *limu*, the ocean near the project area abounds with all kinds of fish. Both Mr. Mahi and Mr. Ako fished in the ocean for *aku* and bonito near the project area, and they shared their traditional methods of preserving fish in brine solutions. Mr. Kunewa recalled a time when everything was abundant. "The *limu kohu* down the side of the cliff, the fish dancing all around you, and seeing the black crabs crawling all over, like a lava flow..."

There are no springs or ponds located in the project area; however, there are dozens of water collection lava tubes identified during the archaeological inventory survey. As described in more detail in the archaeological reports (see Bell et al. 2008a, b, c; Esh et al. 2008), most of these subterranean water sources are relatively small and require intensive and careful methods of collection, including building of small rock structures to hold *ipu* (gourds) in place for days in order to fill them. Both Mr. Mahi and Mr. Haleamau knew of caves that were used as fresh water collection sites, although the latter also had the use of a ranch-owned well.

In addition to these water collection lava tubes, which were probably used most intensively in pre-Contact times, community participants recall using anchialine ponds in the *makai* areas of Kaloko and Kohanaiki in historic times as drinking water for themselves and for their animals. Mr. Haleamau states that cows from the ranch would be driven over the lava so they could refresh themselves with the brackish water that was high in minerals and good for their health. Mr. Mahi also shared his experience of diving into the deep sea to collect water from the fresh water springs in the ocean, and collecting rain for water.

7.4 Burials

There have been at least 65 burials found at about two dozen sites within the current project area. Most of the community participants were aware of the presence of burials throughout the project area. It was a common practice to use lava caves as burial sites in addition to other uses like water collection and habitation. Mr. Ako remembered his father taking him to an overlook above the project area when he was a little boy, to point out the lava tubes where relatives were buried. Mr. Mahi confirmed the traditional practice of burying loves ones in the caves after wrapping their bodies with tapa cloth. All participants who mentioned the presence of burials in the project area were adamant at preserving the *iwi kūpuna* in place.

7.5 Trails

There were seven trails or trail segments observed during the archaeological inventory survey (Bell et al. 2008a, b, c; Esh et al. 2008). Trails are a common site type within the Kekaha region in general. Although some of the trails in the project area were little more than remnants, several run many hundreds of meters and are in good-to-excellent condition. The intersection of three of the trails is especially of interest, as it appears to represent trail use during subsequent periods of time. The construction type also is indicative of changing needs in transportation, specifically the creation of trails more amenable to travel by horse or other pack animal.

The trails indicate a network of transportation corridors that focus on transportation over the large *'a'ā* flow that dominates the project area, with *mauka/makai* and cross slope-oriented trails. The network of trails thus provides fairly direct coast-to-uplands routes via the project area and access to activity areas within the project area. The activity areas include: agricultural pursuits, a ceremonial site, and temporary and recurrent habitation sites, as well as an animal husbandry area. Overall the trails suggest a high level of energy investment in constructing paths for traversing the *'a'ā* flow, both in pre-Contact times as well as historically.

OHA's response letter highlights the importance of the "Road to Sea" trail that has been a subject of some controversy in past archaeological projects, given the uneven nature of its preservation and integrity as a historic property. OHA strongly advocates for a relatively broad interpretation of this particular trail's importance and significance to the wider Kona community, rather than a more narrow scientific view that some or much of the trail has been altered beyond its "traditional" design or intent. Many older people from this area used this "Road to the Sea" trail during the early twentieth century for subsistence purposes.

Several community participants described their use of trails during their childhood and adult years. Mr. Haleamau mentioned three trails, including a secret one that he called "Uluwini." All

three trails began *mauka* and branched out depending on their use, whether to lead Hawaiians to another *ahupua'a* or to the ocean to gather fish. Mr. Mahi stated there numerous *mauka-makai* trails in the project area and warned against blocking the trails with houses. Mr. Keanaaina noted the custom of one family being designated to maintain each trail, and that trail would then be named after them.

7.6 Hunting

A variety of animals were present in the project area into historic times, including wild pigs and goats. The presence of ranches such as Hu'ehu'e Ranch also meant numerous cattle abounded in the area.

Section 8 Summary and Recommendations

At the request of Stanford Carr Development, LLC, Cultural Surveys Hawai'i, Inc. (CSH) conducted a cultural impact assessment (CIA) of a 1,150-acre parcel within portions of Kaloko Ahupua'a and Kohanaiki Ahupua'a, North Kona District, Hawai'i Island, TMK: [3] 7-3-009:017, 025, 026, 028 (see Figures 1-3).

In addition to conducting background research into the traditional and historic importance of the project area, in the context of Kaloko and Kohanaiki Ahupua'a, including results from previous archaeological studies, CSH also made a substantial effort to consult with community members and organizations. A total of twenty-five people were contacted for the purposes of this CIA; 18 people responded; and 12 *kūpuna* and/or *kama'āina* were interviewed for more in-depth contributions. At this writing, a total of nine of these individuals have consented to have their testimonies included in this report. Efforts at obtaining permission to include the testimonies of the remaining three individuals who were interviewed for this CIA are ongoing.

8.1 Summary of Results

Background research conducted for this project yields the following results:

1. The project area is part of the traditional region known as Kekaha, extending from Honokōhau to 'Anaeho'omalu in North Kona. Mary Kawena Pukui notes that Kekaha, within which Kaloko and Kohanaiki Ahupua'a are located, is known "for its scarcity of water but is dearly loved by its inhabitants" (Pukui 1983:185). Despite being a dry place, the project area contains many unique resources—including dozens of subterranean lava tubes and caverns used to collect water; the project area included an extensive pre-Contact Hawaiian settlement that continued to support a subsistence-based lifestyle into the early historic era.
2. Archaeological research shows the project area contains hundreds of culturally and historically significant sites and thousands of individual features within these sites; adjacent areas contain even more significant sites and features. Sites in the project area include permanent and temporary habitation structures—many of which incorporate natural features of subterranean lava tubes into their design, agricultural features (including extensive rock mounds used to plant sweet potatoes), at least 65 burials located in approximately two dozen burial sites, *ahu* (stone markers), trails, petroglyphs, *ahupua'a* boundary walls, *papamū* (traditional gaming site), and others.
3. Radiocarbon dating from nearby sites definitively shows the general area has been utilized by humans for at least 1,000 years.
4. The project area is likely to contain substantial additional subsurface deposits—as yet undiscovered and undocumented—associated with lava tubes and subterranean chambers, including burials and other highly sacred materials.

5. The project area is also associated with the unique history of Hawaiian-style ranching and *paniolo* ("Hawaiian cowboys"), including the well-documented Hu'ehu'e Ranch.
6. Because of its association with Kaloko and Kohanaiki Ahupua'a and the Kekaha region, the project area is associated with specific *mo'olelo* (oral history) about (a) the sixteenth or seventeenth century ruler of Hawai'i Island Lonoikamakahiki (Lono-i-ka-makahiki), who was involved in several famous battles with the chiefs of Maui (including Kama-lala-walu) and other parts of Hawai'i, (b) Kamehameha I, whose remains were reportedly interred near Kaloko Fishpond (*makai* of the project area), (c) 'Umi-a-Liloa, who frequented the famous fisheries of Kaloko and Kohanaiki, and (d) the Nahulu chiefs (including Ka-me'e-ia-moku and Ka-manawa); the project area is also associated with more legendary references to Ka-Miki, various *mo'o* (water spirits) that resided at fishponds at and near the seashore, and Hualālai; and more general references to water-collection lava tubes and the unique environmental conditions of the region (e.g., the heavy night dew that formed and was carefully used by gardeners to grow sweet potatoes and other foods in a seemingly marginal environment).

Community consultation conducted for this project yields the following results:

1. Several participants voiced negative feelings and opinions about the overall cumulative impacts of ongoing and future developments in Kona District and the project area environs pointing out such factors as a diminished quality of life for locals, dwindling resources, prices beyond the reach of most *kama'āina* and overtaxed infrastructure as contributing to a loss of what is authentic and traditional about Kona.
2. Several participants talked about subsistence resources that were previously available to, and enjoyed by, locals—such as various *limu* (seaweeds), crabs and fish—but that are no longer available or easily accessed due to the cumulative impacts of development in Kona.
3. Most participants talked about the presence of burials and *iwi kūpuna* (ancestral remains) throughout the project area. It is clear from some of the interviews that there are many lineal and/or cultural descendents to some of these burials that should be consulted during the proposed development, since some historic-era family burial sites, in particular, may be impacted by the subject project.
4. A few participants talked specifically about changing patterns of vegetation and plant life, highlighting the loss of native and Polynesian-introduced species as well as useful historic introductions such as mango trees. In particular, there is a remnant area of lowland forest in the project area containing several endangered and threatened native species, including *ko'oko'olau* (*Bidens* spp.). It is important to understand that such natural

resources are significant cultural and historical resources to many native Hawaiians.

5. A few participants talked about drinking from water collection caves in historic times, as they moved around the landscape (e.g., as ranchers), and of brackish pools used by their animals (e.g., cattle and horses).
6. Several individuals discussed trails in the project area, including a historic trail running from the ocean to the mountains (this is the so-called "Road to the Sea") along the *ahupua'a* boundary between Kaloko and Kohanaiki, that were used in the recent memories of some participants to gather resources from the sea and the uplands. Given many changes and modern developments, the trails in the project area have not been used by many people for several decades.

8.2 Recommendations

The following recommendations are based on a synthesis of all the information gathered during preparation of this CIA. Faithful attention to these recommendations, and efforts to develop appropriate measures to address these concerns, will help mitigate the adverse impacts of the proposed action on Hawaiian cultural beliefs, practices and resources by the project:

1. Most of the people who voiced negative feelings and opinions about the overall cumulative impacts of ongoing and future developments in Kona District stopped short of saying they were entirely opposed to the proposed project; however, some participants recommended the project proponent prepare a draft Master Plan for review and comment by the public so that the various short- and long-term cumulative impacts, both negative and positive (e.g., the construction of recreational facilities and/or parks and other "green spaces"), can be assessed by the community.
2. Several participants, including the Office of Hawaiian Affairs (OHA), recommend the project proponents work together with the local community in order to develop plans that are *pono* (i.e., harmonious with the local environment), culturally sensitive and fair and balanced with respect to the *'āina* and its natural and cultural resources.
3. Efforts should be made to protect and preserve brackish water pools and water collection lava tubes.
4. Most participants strongly urged that no burials or *iwi kūpuna* (ancestral remains) should be relocated or moved to make way for the proposed project.
5. One participant who worked as a *paniolo* for many years recommended preservation and protection of "holding corrals" (*puakini*) in order to educate present and future generations about the unique Hawaiian-style "cowboys" that flourished in and around the subject project area in historic times.

6. Efforts should be made to preserve and protect all trails in the project area, including designing around trails to maintain an authentic sense of place that is unique to Kona.
7. Efforts should be made to preserve and protect the remnant lowland forest and any other native and Polynesian-introduced plants species in the project area, including *ko'oko'olau* plants and other endangered and threatened species. Preparation of a "vegetation master plan," which could be combined with the next item (below), would help guide plans and commitments to preserve and protect these unique resources.
8. Several participants stated that, if the proposed development goes forward, it should use environmentally-appropriate landscaping that enhances the sense of place, including native and Polynesian-introduced species. Preparation of a "vegetation master plan," which could be combined with the previous item (above), would help guide plans and commitments to preserve and protect these unique resources.
9. OHA, in particular, recommends the project proponents faithfully follow all applicable laws with respect to the treatment of all historic properties located within the subject project area.
10. Cultural monitoring should be conducted during all phases of development, including all significant ground disturbances, to ensure that significant cultural and historical resources are protected and preserved in accordance with appropriate mitigation plans.
11. Community members and groups responsible for the long-term care of the Kohanaiki and Kaloko Ahupua'a, as well as cultural practitioners who utilize the area for gathering and for cultural and educational activities, should be further consulted regarding the above issues and other concerns throughout the planning, development and operation of the proposed housing development. This consultation should include all interested community groups and individuals who have a stake in the project area.

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Appendix A OHA Response Letter

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STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
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HONOLULU, HAWAI'I 96813

April 24, 2008

HRD08-3552

Margaret Magat, Researcher
Cultural Surveys Hawai'i, Inc.
P.O. Box 1114
Kailua, Hawai'i 96734

Re: **Cultural Impact Assessment**
Kohanaiki and Kaloko Ahupua'a
North Kona District, Island of Hawai'i

Dear Ms. Magat:

The Office of Hawaiian Affairs (OHA) is in receipt of your letter initiating consultation ahead of a cultural impact assessment for a 1,150 acre project located in Kohanaiki and Kaloko Ahupua'a. Based on the information contained within your letter, it is our understanding that Stanford Carr Development has proposed development plans which include residential units, commercial and neighborhood retail centers, recreational facilities, schools and associated infrastructure.

OHA recommends that your firm conduct a thorough review of all archaeological reports and cultural studies related to the larger area which will be subject to the cultural impact assessment.

OHA requests that a comprehensive archaeological inventory survey for the project area be conducted and submitted to the Department of Land and Natural Resources-Historic Preservation Division for review and approval. OHA should be allowed the opportunity to comment on the criteria assigned to any cultural or archaeological sites identified within the archaeological inventory survey pursuant to §13-284-6(e), Hawai'i Administrative Rules. Consideration should also be afforded to any individuals accessing the project area for constitutionally protected traditional and customary purposes.

We are aware that numerous cultural sites and resources were identified within the "Kaloko Heights" project area which is adjacent to this proposed development. Numerous families have been recognized as cultural descendants to burials within the "Kaloko Heights" project area by the Hawai'i Island Burial Council. OHA recommends that consultation occur with these families occur regarding cultural sites and resources within the proposed development area. The Historic Preservation Division should be able to provide you with the names of these families.

Margaret Magat
Cultural Surveys Hawai'i, Inc.
April 24, 2008
Page 2

Community groups such as "Kahu o Kahiko" should also be consulted regarding cultural sites and resources within the proposed development area.

The maps included with your letter which depict the proposed development area indicate that it is highly probable that the "Road to the Sea" trail is within the boundaries of the proposed development area. OHA strongly advocates that the "Road to the Sea" trail alignment be preserved in perpetuity.

Please note that the significance members of the Hawaiian community associate with this trail are not being conjured up from stories of a distant past. There are kama'āina of Kona still living today who recall accessing this trail to gather land and ocean resources for subsistence. These are traditional and customary practices which are protected by the Constitution of the State of Hawai'i as well as in the Hawai'i Revised Statutes and in court decisions. While the constant and active use of this trail may have faded through the years due to multiple factors, the passage of time and physical changes can never eliminate the trail's history and significance to the Hawaiian people.

Thank you for initiating consultation at this early stage. We look forward to the opportunity to review the completed cultural impact assessment. Should you have any questions, please contact Keola Lindsey, Lead Advocate-Culture at (808) 594-1904 or keolal@oha.org.

'O wau iho nō,

Clyde W. Nāmu'o
Administrator

C: Ruby McDonald, OHA- Community Resource Coordinator- West Hawai'i
75-5706 Hanama Place, Suite 107
Kailua-Kona, Hawai'i 96740

Appendix M

Traffic Impact Study for Kaloko Makai
KOA Corporation
July 2011

Traffic Impact Study for Kaloko Makai Village in Kona, Hawaii

Prepared For:

Wilson Okamoto Corporation
1907 South Beretania St, Ste 400
Honolulu, HI 96826

Prepared by:

KOA CORPORATION
PLANNING & ENGINEERING
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Job Number: JB03140

July 22, 2011

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1. Introduction

The purpose of this report is to assess the proposed Kaloko Makai Village project's traffic impact on the existing and future roadway network in vicinity of the project. This report documents the existing and future years (Year 2015, 2025 and 2035) roadway conditions and operation performance, forecast traffic volumes, methodology used in roadway segment and intersection Level of Service (LOS) analysis, and recommendations for roadway improvement.

1.1 Project Description

The project site is located east of Queen Ka'ahumanu Highway (State Route 19) and along the north and south sides of Hina Lani Street in Kona on the Hawaii (Big) Island. The project vicinity map is shown on Figure 1.

The proposed Kaloko Makai Village project is a 1,139-acre mixed-use development consists of over 20 different types of land uses. Conceptual land use plan is shown on Figure 2*. Additional details for the proposed land use are included in Appendix A of this report. The proposed mixed-use project includes the following land uses:

- Transit station
- Light industrial
- Waste waster treatment plant
- Single-family detached housing
- Affordable multi-family
- Market multi-family
- Multi-family market senior
- Multi-family affordable senior
- Live-work units
- Lodge (hotel)
- District park, TOD park
- Elementary school, middle school
- Hospital/medical center
- Long-term care facility
- Legal office, retail-office
- Urgent care/clinic, medical office
- Judiciary (government) building
- Fire station
- Police sub-station
- Retail, shopping center

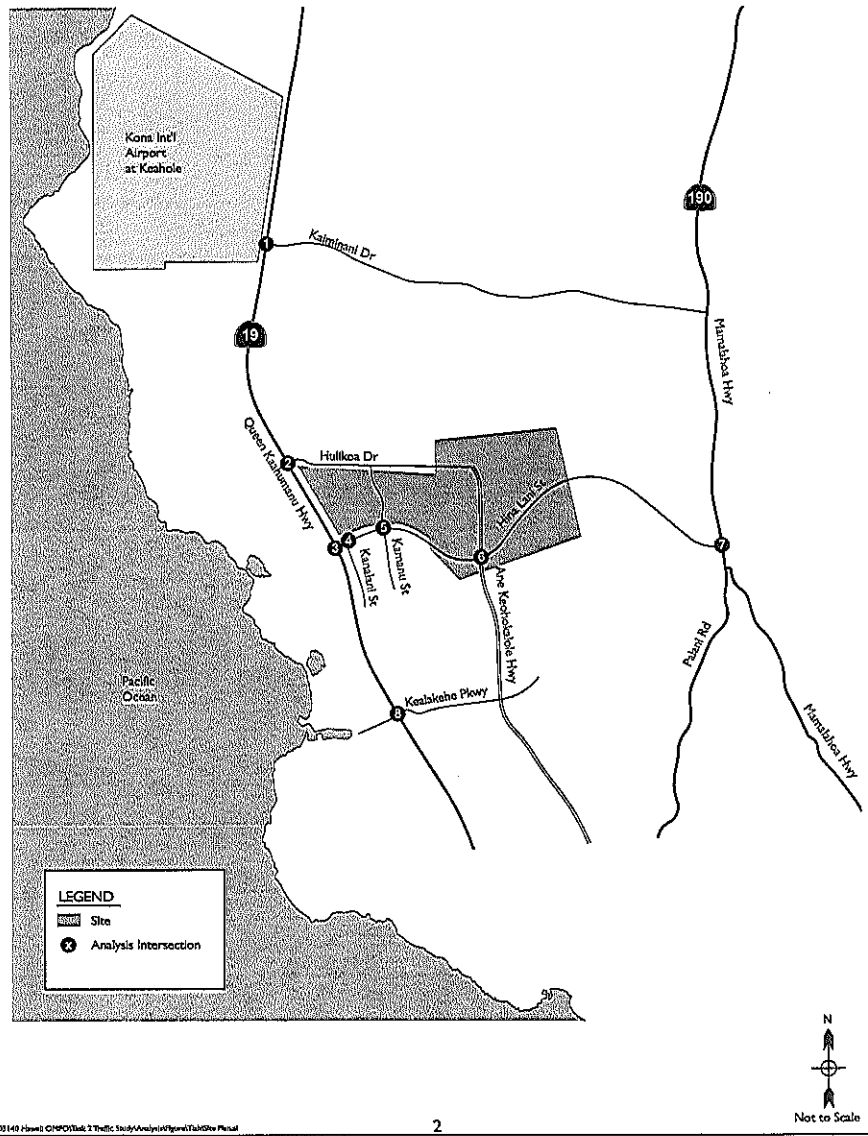
1.2 Project Phasing

The project is expected to be developed in 3 phases with the development of each phase expected to a period of 10 years starting in the Year 2015. Although each phase is expected to be developed gradually over 10 years, for the purpose of this report, the horizon years for the phases was conservatively designated at the beginning of each 10 year development period to ensure concurrency of the implementation of the recommended improvements. As such, the study horizon years area as follows:

- Phase 1 – 2015
- Phase 2 – 2025
- Phase 3 – 2035

The project phasing plan is shown on Figure 3. For the purpose of this analysis, the project site is divided in to 7 traffic analysis zones (TAZ).

*Subsequent to the preparation of this report, the land use plan was modified; however, those modifications do not significantly alter the analysis and general findings of this report.



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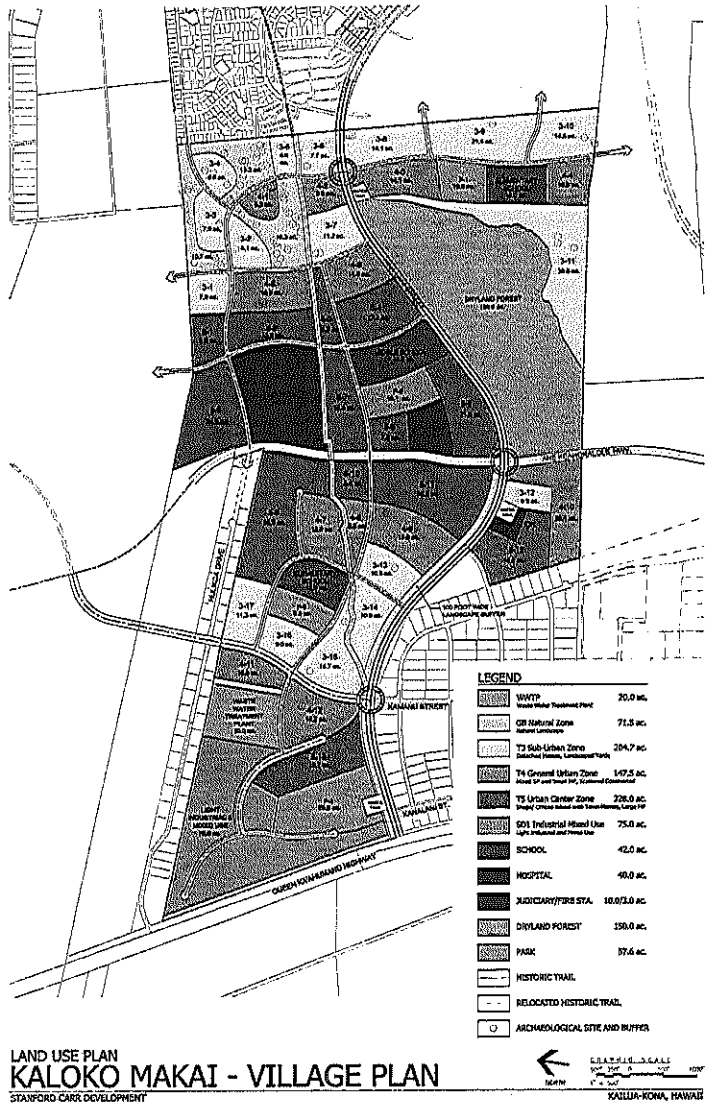
Kona, Hawaii	Figure 1
Kaloko Makai Project	Vicinity Map



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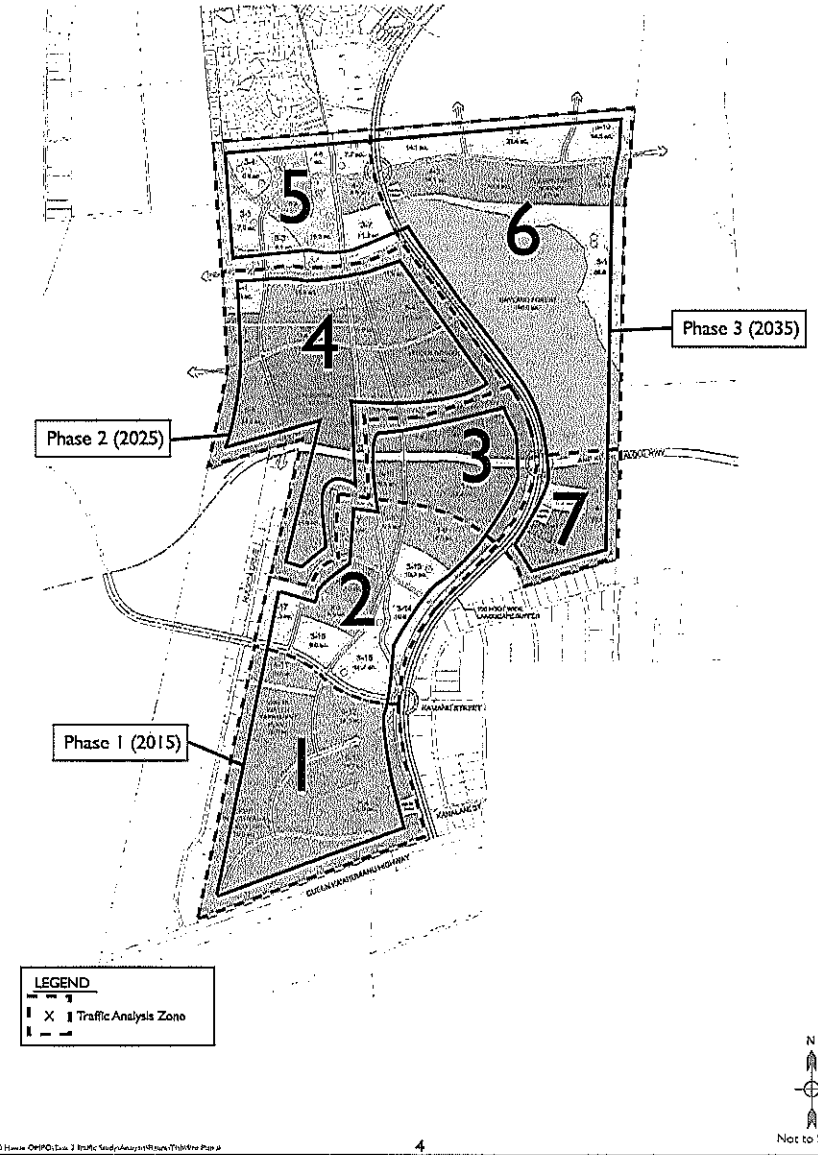
Kona, Hawaii — Figure 2

Kaloko Makai Project — Conceptual Land Use Plan



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Kona, Hawaii — Figure 3

Kaloko Makai Project — Project Traffic Analysis Zones (TAZ) and Phasing Plan

2. Traffic Operations Analysis Methodology

This section documents the methodologies and assumptions used to conduct the traffic operations analysis for the project site. The following background information is included:

- Study scenarios
- Study area description
- Capacity analysis methodologies

2.1 Study Scenarios

This report presents an analysis of the intersection operating conditions during the AM and PM peak hours for the following anticipated timeframes:

- Existing Condition
- 2015 Baseline Condition (without Project)
- 2015 with Project Phase 1 Condition
- 2025 with Project Phase 2 Condition
- 2035 with Project Phase 3 Condition

2.2 Project Study Area

The study area consists of the following eight intersections:

- Queen Ka'ahumanu Highway at Ka'iminani Drive
- Queen Ka'ahumanu Highway at Hulikoa Drive
- Queen Ka'ahumanu Highway at Hina Lani Street
- Kanalani Street at Hina Lani Street
- Kamanu Street at Hina Lani Street
- Ane Keahokalole Highway at Hina Lani Street
- Mamalahoa Highway at Hina Lani Street
- Queen Ka'ahumanu Highway at Kealakehe Parkway

2.3 Analysis Methodologies

This section presents a brief overview of traffic analysis methodologies and concepts used in this study. Street system operating conditions are typically described in terms of level of service (LOS). Level of service is a report-card scale used to indicate the quality of traffic flow on roadway segments and at intersections. Levels of service range from Level A (free flow, little congestion) to Level F (forced flow, extreme congestion).

Intersection level of service analysis was conducted using Synchro 6.0 software which applies the principles or the specific analysis methods contained in the *Highway Capacity Manual*, 2000 Edition (*HCM*), a publication of the Transportation Research Board, a research agency affiliated with the Federal Government. Chapter 9 of the *HCM* is devoted to analysis of signalized intersections and Chapter 10 is devoted to the analysis of unsignalized intersections. The methodology in the *HCM* for signalized intersections is based upon measurements or forecasts of control delay for traffic utilizing all approaches to the intersection. Intersection average delay and poorest movement delay are reported for all unsignalized intersections. Table 1 defines the level of service and control delay ranges for signalized and unsignalized intersections.

Table 1 – Levels of Service for Intersections

Level of Service	Signalized Intersection Control Delay (seconds/vehicle)	Unsignalized Intersection Control Delay (seconds/vehicle)
A	0 to 10	0 to 10
B	10.1 to 20	10 to 15
C	20.1 to 35	15 to 25
D	35.1 to 55	25 to 35
E	55.1 to 80	35 to 50
F	More than 80	More than 50

Source: Highway Capacity Manual, 2000.

A lane capacity of 1,900 vehicles per hour per lane and a 2 second loss time per phase were used for this study. Unsignalized intersections were analyzed using the *HCM 2000* method for unsignalized intersections. Level of Service D or better are considered as acceptable.

Intersection operations analysis was conducted using Synchro 6.0 computer analysis software.

3. Future Traffic Forecast Methodology

This section documents the methodologies and assumptions used to forecast the future traffic volumes for the project vicinity. The following background information is included:

- Existing traffic count data
- Trip generation rates
- Pass-by trip reduction
- Internal trip capture
- Transit trip discount
- Project traffic generation
- Project trip distribution patterns
- Other cumulative development traffic
- Ambient background growth

It should be noted that the overall future traffic forecast is a worst-case scenario because this analysis utilized a conservative approach in the overall traffic projection. The project trip reduction adjustments, such as pass-by trips and transit discounts that are used in this analysis are conservatively low. In addition to accounting for cumulative development traffic in the vicinity of the project site, a conservatively-high ambient background growth factor is also used to assess other unidentified projects and general population growth traffic that may contribute to overall traffic growth.

3.1 Existing Traffic Count Data

Wilson Okamoto Corporation conducted traffic turning movement counts at existing seven study area intersections on Tuesday, September 21, and Wednesday, Sept 22, 2010. The AM and PM peak hour counts were conducted from 6:00 AM to 9:00 AM and from 3:00 PM to 6:00 PM, respectively. Traffic count data sheets are included in Appendix B of this report. Existing traffic counts are summarized on Table 2.

3.2 Trip Generation Rates

This study used the nationally recognized trip rates, published by the Institute of Transportation Engineers (ITE), 8th Edition, to determine the site-only traffic volumes generated by the proposed Kaloko Makai Village project. Based on the proposed land use plan, the following ITE trip rates are used for the project land uses:

- Park-and-Ride Lot with Bus Service (ITE Code 090): Transit station
- General Light Industrial (ITE Code 110): Light industrial
- Utilities (ITE Code 170): Waste waster treatment plant
- Single-Family Detached Housing (ITE Code 210)

Table 2 - Existing Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kalmanani Dr.	AM	0	562	102	25	374	0	0	0	0	480	0	221	1,764
		PM	0	497	380	200	623	0	0	0	0	180	0	69	1,949
2	Queen Kaahumanu Hwy./Hulikoa Dr.	AM	0	590	141	77	679	0	0	0	0	79	0	103	1,669
		PM	0	719	65	57	891	0	0	0	0	120	0	85	1,937
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	472	373	159	680	0	0	0	0	217	0	198	2,099
		PM	0	584	527	214	704	0	0	0	0	469	0	275	2,773
4	Kanalani St./ Hina Lani St.	AM	225	0	13	0	0	0	0	137	363	13	210	0	961
		PM	200	0	56	0	0	0	0	202	489	6	456	0	1,409
5	Kamanu St./ Hina Lani St.	AM	112	0	54	0	0	0	0	47	90	100	120	0	523
		PM	373	0	223	0	0	0	0	116	94	94	66	0	966
6	Ane Keohuokalole Hwy./Hina Lani St.	AM	0	0	0	0	0	0	0	101	0	0	220	0	321
		PM	0	0	0	0	0	0	0	339	0	0	160	0	499
7	Mamalahoa Hwy./ Hina Lani St.	AM	119	274	0	0	956	131	57	0	79	0	0	0	1,616
		PM	77	511	0	0	391	86	190	0	210	0	0	0	1,465
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	68	628	294	158	619	48	17	7	24	229	18	138	2,248
		PM	60	851	156	52	991	44	59	19	71	210	20	54	2,587

- Apartments (ITE Code 220): Affordable multi-family
- Residential Condominium/Townhouse (ITE Code 230): Live-work units, multi-family
- Senior Adult Housing-Attached (ITE Code 252): MF market senior, MF affordable senior
- Hotel (ITE Code 310): Lodge
- County park (ITE Code 412): District park, TOD park
- Elementary School (ITE Code 520): Elementary school
- Middle School/Junior High School (ITE Code 522): Middle school
- Hospital (ITE Code 610): Hospital/medical center
- Nursing Home (ITE Code 620): Long-term care facility
- General Office Building (ITE 710): Legal office, retail-office
- Medical-Dental Office Building (ITE Code 720): Urgent care/clinic, medical office
- Government Office Building (ITE 730): Judiciary, fire station, police sub-station
- Shopping Center (ITE Code 820): Retail, shopping center

Trip reduction adjustment has been made to the overall project traffic generation to account for pass-by trips, internal capture and transit trip discount. The reduction percentage assumption has been based on past experience for this type of development and the reference information obtained from other studies in the area.

3.3 Pass-By Trip Reduction

Pass-by trip is a portion of traffic generated by retail uses already on the road stopping at a secondary destination on its way to an ultimate destination. For instance, a driver that got off from work at an off-site location on his way home may stop by a retail center along his route to do some shopping, and his shopping trip is considered a pass-by trip already on the road because it is not a new trip generated by the retail center impacting the external roadway network. This study uses a conservatively-low 15% pass-by trip discount factor to reduce the retail trips for the PM peak hour and daily traffic conditions.

3.4 Internal Trip Capture

Internal capture is a portion of traffic that visits multiple uses within the project boundary on a single trip. An example may be a patient that visits the medical clinic and then goes shopping afterwards at an adjacent retail center without driving out of the project boundary. His shopping trip would be considered an internal capture trip already accounted for by his medical office trip. Internal capture trip discount factors have been estimated based on the Multi-Use Development trip generation methodology stated in the ITE Trip Generation Handbook. Internal capture factors are assessed on the interactions for the residential, office and commercial retail uses within the same Traffic Analysis Zones (TAZ). For the purpose of this traffic analysis, the project land use plan is divided into 7 TAZ's, and internal capture trip discount factors have been calculated within each TAZ for AM peak hour, PM peak hour and daily traffic conditions. The project TAZ boundary is previously shown on Figure 3. The internal capture trip calculation worksheets are included in Appendix C of this report.

3.5 Transit Trip Discount

Transit trip is a portion of traffic that utilizes public transportation or vanpool opportunities instead of driving alone in personal vehicles to their destinations. For instance, a driver may drive from his residence to a near-by park-and-ride facility to ride a bus to go to work at a further destination. Transit discount factor is assessed based on the available transit-oriented development and opportunities in the surrounding community. The County of Hawaii Mass Transit Agency provides an island-wide public bus transit system, called Hele-on Bus. The Hele-on Bus currently provides bus service along Queen Ka'ahumanu Highway (State Route 19) in the study area. A transit station, similar to a park-and-ride lot with bus service, is proposed in the project land use plan. Based on a review of the available transit opportunities for the project site, this study has included a conservatively-low 5% transit trip discount factor to account for traffic utilizing transit-oriented opportunities. It should be noted, however, in accordance with the Kona Community Development Plan (KCDP), Ane Keokokalole Highway is eventually expected to be a transit corridor with transit oriented developments along its proposed alignment. In the future, this roadway is expected to extend further north and new transit routes are expected to be established along its alignment. At that time, transit may have a more significant effect on reducing vehicular trips generated by the proposed project.

3.6 Project Traffic Generation

Table 3 summarizes the project traffic generation for the proposed Kaloko Makai project. As shown on Table 3, the proposed project is anticipated to generate 5,702 AM peak hour trips and 6,131 PM peak hour trips, with pass-by, internal capture and transit trip discount adjustments.

3.7 Project Trip Distribution Patterns

Trip distribution is the process of identify the probable destination, direction or traffic routes that will be utilized by project traffic. The potential interaction between the proposed land use and surrounding regional access routes are considered when identifying the route where the project traffic will distribute. Approved and proposed roadway improvements and programs have been reviewed to determine the study area roadway network for the 3 different analysis phasing years (2015, 2025 and 2035) being analyzed in the traffic impact analysis.

This study used the existing traffic volumes and the surrounding land use and geographic conditions to determine the trip distribution patterns. The project's overall external trip distribution patterns for the proposed Kaloko Makai project are shown on Figure 4. The trip distribution patterns for the 7 project TAZ's are shown on Figures 5 through 11.

Based on the traffic generation and trip distribution patterns presented above, project-only traffic volumes are shown on the following tables and figures for the 3 project phases:

Table 3 (1 of 5) - Project Traffic Generation

TRIP GENERATION RATES

ITE Code	ITE Description	Unit	Daily	AM Total	AM In	AM Out	PM Total	PM In	PM Out
90	Park-and-Ride Lot with Bus Service	AC	372.32	46.81	39.54	9.27	43.75	18.04	25.69
110	General Light Industrial	AC	51.80	7.51	6.23	1.28	7.26	1.60	5.66
170	Utilities [1]	AC	12.36	2.49	1.57	0.92	1.32	0.59	0.73
210	Single-Family Detached Housing	DU	9.57	0.75	0.19	0.56	1.01	0.64	0.37
220	Apartment	DU	6.65	0.51	0.10	0.41	0.62	0.40	0.22
230	Residential Condo/Townhouse	DU	5.81	0.44	0.07	0.37	0.52	0.35	0.17
252	Senior Adult Housing-Attached	Occupied DU	3.40	0.13	0.05	0.08	0.16	0.10	0.06
310	Hotel	RM	8.17	0.56	0.34	0.22	0.59	0.31	0.28
412	County Park	AC	2.28	0.07	0.01	0.06	0.06	0.02	0.04
520	Elementary School	STU	1.29	0.45	0.25	0.20	0.15	0.07	0.08
522	Middle School/Junior High School	STU	1.62	0.54	0.30	0.24	0.16	0.08	0.08
610	Hospital	BEDS	11.81	1.14	0.81	0.33	1.31	0.47	0.84
620	Nursing Home	BEDS	2.37	0.17	0.12	0.05	0.22	0.07	0.15
710	General Office Building	TSF	11.01	1.55	1.36	0.19	1.49	0.25	1.24
720	Medical-Dental Office Building	TSF	36.13	2.30	1.82	0.48	3.46	0.93	2.53
730	Government Office Building	TSF	68.93	5.68	4.94	0.94	1.21	0.38	0.83
820	Shopping Center	TSF	42.94	1.00	0.61	0.39	3.73	1.83	1.90

Source: ITE (Institute of Transportation Engineers) Trip Generation Manual, 8th Edition, 2008.
[1] Trip rate for daily is not available in ITE Trip Generation. The daily to AM/PM peak hours ratio for general light industrial use was applied to the AM plus PM peak hour rates to estimate the daily trip rate for utilities use.

PROJECT TRAFFIC GENERATION

Project Description	Parcel I.D.	TAZ	ITE Code	ITE Description	Quantity / Unit	Daily	AM Total	AM In	AM Out	PM Total	PM In	PM Out
Project Phase 1												
Waste Water Treatment Plant	WWTP	1	170	Utilities	20.00 ac	267	50	31	19	26	12	14
Light Industrial	SD1	1	110	General Light Industrial	75.00 ac	3,885	563	467	96	545	120	425
District-scale Park	P-4	1	412	County Park	25.00 ac	57	0	0	0	2	1	1
MF Affordable	T5-13	1	220	Apartment	335 du	2,228	171	34	137	208	134	74
Live-Work	T4-11	1	230	Residential Condo/Townhouse	80 du	465	35	6	29	42	28	14
Retail	T4-11	1	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Office	T4-11	1	710	General Office Building	10 tsf	110	16	14	2	15	3	12
Live-Work	T4-12	1	230	Residential Condo/Townhouse	130 du	755	57	9	48	68	46	22
Retail	T4-12	1	820	Shopping Center	20 tsf	859	20	12	8	75	37	38
Office	T4-12	1	710	General Office Building	20 tsf	220	31	27	4	30	5	25
Single-Family	T3-17	2	210	Single-Family Detached Housing	57 du	545	43	11	32	88	36	22
Single-Family	T3-16	2	210	Single-Family Detached Housing	36 du	345	27	7	20	36	23	13
Single-Family	T3-15	2	210	Single-Family Detached Housing	74 du	708	56	14	42	75	47	28
Single-Family	T3-14	2	210	Single-Family Detached Housing	54 du	517	41	10	31	55	35	20
Single-Family	T3-13	2	210	Single-Family Detached Housing	82 du	785	62	16	46	83	52	31
Retail	T3-13	2	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Office	T3-13	2	710	General Office Building	10 tsf	110	16	14	2	15	3	12
TOD Park	P-3	2	412	County Park	9.50 ac	22	0	0	0	1	0	1
Elementary School	Elem School	2	520	Elementary School	450 stu	581	203	113	90	68	32	36
MF Market Senior (6.9-acres)	T4-7	2	252	Senior Adult Housing-Attached	53 du	191	7	3	4	9	6	3
Live-Work (6-acres)	T4-7	2	230	Residential Condo/Townhouse	48 du	279	21	3	18	25	17	8
Retail	T4-7	2	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Office	T4-7	2	710	General Office Building	15 tsf	165	23	20	3	22	4	18
MF Market Senior (2.5-acres)	T4-8	2	252	Senior Adult Housing-Attached	20 du	70	3	1	2	3	2	1
Live-Work (3-acres)	T4-8	2	230	Residential Condo/Townhouse	24 du	139	11	2	9	12	8	4
Retail	T4-8	2	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Office	T4-8	2	710	General Office Building	15 tsf	165	23	20	3	22	4	18
Live-Work	T4-9	2	230	Residential Condo/Townhouse	152 du	883	67	11	56	79	53	26
Retail	T4-9	2	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Office	T4-9	2	710	General Office Building	25 tsf	275	39	34	5	37	6	31
Transit Station	T5-10	3	090	Park-and-Ride Lot with Bus Service	1.63 ac	605	79	64	15	71	16	55
Multi-Family	T5-10	3	230	Residential Condo/Townhouse	90 du	569	43	7	36	51	34	17
Retail	T5-10	3	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Office	T5-10	3	710	General Office Building	25 tsf	275	39	34	5	37	6	31
Multi-Family	T5-11	3	230	Residential Condo/Townhouse	230 du	1,206	101	16	85	120	81	39
Shopping Center	T5-11	3	820	Shopping Center	175 tsf	7,515	175	107	68	653	320	333
Urgent Care/Clinic	T5-11	3	720	Medical-Dental Office Building	25 tsf	903	58	46	12	87	23	64
Multi-Family	T5-6	3	230	Residential Condo/Townhouse	100 du	627	48	8	40	56	38	18
Retail	T5-6	3	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Office	T5-6	3	710	General Office Building	25 tsf	275	39	34	5	37	6	31
Judiciary (10 Acres)	Judiciary	3	730	Government Office Building	108.90 tsf	7,506	640	530	102	132	41	91
Multi-Family	T5-5	3	230	Residential Condo/Townhouse	237 du	1,377	104	17	87	123	83	40
Retail	T5-5	3	820	Shopping Center	50 tsf	2,147	50	31	19	187	92	95
Legal Office	T5-5	3	710	General Office Building	100 tsf	1,101	155	136	19	149	25	124
				Phase 1 Total without Trip Discounts		43,600	3,231	1,986	1,245	3,741	1,689	2,052

Table 3 (2 of 5) - Project Traffic Generation

PROJECT TRAFFIC GENERATION

Project Description	Parcel I.D.	TAZ	ITE Code	ITE Description	Quantity / Unit	Daily	AM Total	AM In	AM Out	PM Total	PM In	PM Out
Phase 1, TAZ 1												
Waste Water Treatment Plant	WWTP	1	170	Utilities	20.00 ac	267	50	31	19	26	12	14
District-scale Park	P-4	1	412	County Park	25.00 ac	57	0	0	0	2	1	1
MF Affordable	T5-13	1	220	Apartment	335 du	2,228	171	34	137	208	134	74
Live-Work	T4-11	1	230	Residential Condo/Townhouse	80 du	465	35	6	29	42	28	14
Live-Work	T4-12	1	230	Residential Condo/Townhouse	130 du	755	57	9	48	68	46	22
				Subtotal	545 du	3,440	263	49	214	318	208	110
				Internal Capture (6% Daily, 2% AM, 4% PM)		-207	-5	-1	-4	-13	-8	-5
				Transit Trip Discount	5%	-172	-13	-2	-11	-16	-10	-6
				Total (less Internal/Transit Trips)		3,061	245	46	199	289	190	99
Retail	T4-11	1	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Retail	T4-12	1	820	Shopping Center	20 tsf	859	20	12	8	75	37	38
				Subtotal	30 tsf	1,288	30	18	12	112	55	57
				Internal Capture (6% Daily, 2% AM, 4% PM)		-77	-1	0	-1	-4	-2	-2
				Transit Trip Discount	5%	-64	-2	-1	-1	-6	-3	-3
				Total (less Internal/Transit Trips)		1,147	27	17	10	102	50	52
				Pass-by Trip Discount	15%	-172	0	0	0	-15	-8	-7
				Total (less Internal/Transit/Pass-by Trips)		975	27	17	10	87	42	45
Light Industrial	SD1	1	110	General Light Industrial	75.00 ac	3,885	563	467	96	545	120	425
Office	T4-11	1	710	General Office Building	10 tsf	110	16	14	2	15	3	12
Office	T4-12	1	710	General Office Building	20 tsf	220	31	27	4	30	5	25
				Subtotal		4,215	610	508	102	590	128	462
				Internal Capture (6% Daily, 2% AM, 4% PM)		-253	-12	-10	-2	-24	-5	-19
				Transit Trip Discount	5%	-211	-31	-25	-6	-30	-6	-24
				Total (less Internal/Transit Trips)		3,751	567	473	94	536	117	419
		1		Total w/ Internal/Transit & w/o Pass-by Trip Discount		8,291	889	567	322	955	370	585
		1		Total w/ Internal/Transit/Pass-by Trip Discount		8,119	889	567	322	940	363	578
Phase 1, TAZ 2												
Single-Family	T3-17	2	210	Single-Family Detached Housing	57 du	545	43	11	32	58	36	22
Single-Family	T3-16	2	210	Single-Family Detached Housing	36 du	345	27	7	20	36	23	13
Single-Family	T3-15	2	210	Single-Family Detached Housing	74 du	708	56	14	42	75	47	28
Single-Family	T3-14	2	210	Single-Family Detached Housing	54 du	517	41	10	31	55	35	20
Single-Family	T3-13	2	210	Single-Family Detached Housing	82 du	785	62	16	46	83	52	31
Live-Work (6-acres)	T4-7	2	230	Residential Condo/Townhouse	48 du	279	21	3	18	25	17	8
Live-Work (3-acres)	T4-8	2	230	Residential Condo/Townhouse	24 du	139	11	2	9	12	8	4
Live-Work	T4-9	2	230	Residential Condo/Townhouse	152 du	883	67	11	56	79	53	26
				Subtotal	527 du	4,201	328	74	254	423	271	152
				Internal Capture (9% Daily, 4% AM, 8% PM)		-378	-13	-3	-10	-34	-22	-12
				Transit Trip Discount	5%	-210	-16	-4	-12	-21	-14	-7
				Total (less Internal/Transit Trips)		3,613	299	67	232	368	235	133
Retail	T3-13	2	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Retail	T4-7	2	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Retail	T4-8	2	820	Shopping Center	10 tsf	429	10	6	4	37	18	19
Retail	T4-9	2	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
				Subtotal	55 tsf	2,361	55	33	22	204	100	104
				Internal Capture (9% Daily, 4% AM, 8% PM)		-212	-2	-1	-1	-16	-8	-8
				Transit Trip Discount	5%	-118	-3	-2	-1	-10	-5	-5
				Total (less Internal/Transit Trips)		2,031	50	30	20	178	87	91
				Pass-by Trip Discount	15%	-305	0	0	0	-27	-13	-14
				Total (less Internal/Transit/Pass-by Trips)		1,726	50	30	20	151	74	77
Office	T3-13	2	710	General Office Building	10 tsf	110	16	14	2	15	3	12
Office	T4-7	2	710	General Office Building	15 tsf	165	23	20	3	22	4	18
Office	T4-8	2	710	General Office Building	15 tsf	165	23	20	3	22	4	18
Office	T4-9	2	710	General Office Building	25 tsf	275	39	34	5	37	6	31
				Subtotal	65 tsf	715	101	88	13	96	17	79
				Internal Capture (9% Daily, 4% AM, 8% PM)		-64	-4	-4	0	-8	-1	-7
				Transit Trip Discount	5%	-36	-5	-4	-1	-5	-1	-4
				Total (less Internal/Transit Trips)		615	92	80	12	83	15	68
TOD Park	P-3	2	412	County Park	9.50 ac	22	0	0	0	1	0	1
Elementary School	Elem School	2	520	Elementary School	450 stu	581	203	113	90	68	32	36
MF Market Senior (6.9-acres)	T4-7	2	252	Senior Adult Housing-Attached	53 du	191	7	3	4	9	6	3
MF Market Senior (2.5-acres)	T4-8	2	252	Senior Adult Housing-Attached	20 du	70	3	1	2	3	2	1
		2		Total w/ Internal/Transit & w/o Pass-by Trip Discount		7,123	454	294	360	710	377	333
		2		Total w/ Internal/Transit/Pass-by Trip Discount		6,818	454	294	360	683	364	319

Table 3 (3 of 5) - Project Traffic Generation

PROJECT TRAFFIC GENERATION

Project Description	Parcel I.D.	TAZ	ITE Code	ITE Description	Quantity / Unit	Daily	AM Total	AM In	AM Out	PM Total	PM In	PM Out
Phase 1, TAZ 3												
Transit Station	TS-10	3	090	Park-and-Ride Lot with Bus Service	1.63 ac	605	79	64	15	71	16	55
Multi-Family	TS-10	3	230	Residential Condo/Townhouse	98 du	569	43	7	36	51	34	17
Multi-Family	TS-11	3	230	Residential Condo/Townhouse	230 du	1,236	101	16	85	120	81	39
Multi-Family	TS-6	3	230	Residential Condo/Townhouse	108 du	627	48	8	40	56	38	18
Multi-Family	TS-5	3	230	Residential Condo/Townhouse	237 du	1,377	104	17	87	123	83	40
				Subtotal	673 du	3,909	296	48	248	350	236	114
				Internal Capture (13% Daily, 4% AM, 16% PM)		-508	-12	-2	-10	-56	-38	-18
				Transit Trip Discount	5%	-195	-15	-2	-13	-18	-12	-6
				Total (less Internal/Transit Trips)		3,206	269	44	225	276	186	90
Retail	TS-10	3	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Shopping Center	TS-11	3	820	Shopping Center	175 tsf	7,515	175	107	68	653	320	333
Retail	TS-6	3	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Retail	TS-5	3	820	Shopping Center	50 tsf	2,147	50	31	19	187	92	95
				Subtotal	275 tsf	11,810	275	168	107	1,026	504	522
				Internal Capture (13% Daily, 4% AM, 16% PM)		-1,535	-11	-7	-4	-164	-81	-83
				Transit Trip Discount	5%	-591	-14	-8	-6	-51	-25	-26
				Total (less Internal/Transit Trips)		9,684	250	153	97	811	398	413
				Pass-by Trip Discount	15%	-1,453	0	0	0	-122	-60	-62
				Total (less Internal/Transit/Pass-by Trips)		8,231	250	153	97	689	338	351
Office	TS-10	3	710	General Office Building	25 tsf	275	39	34	5	37	6	31
Urgent Care/Clinic	TS-11	3	720	Medical-Dental Office Building	25 tsf	903	58	46	12	87	23	64
Office	TS-6	3	710	General Office Building	25 tsf	275	39	34	5	37	6	31
Judiciary (10 Acres)	Judiciary	3	730	Government Office Building	100.90 tsf	7,506	640	528	102	132	41	91
Legal Office	TS-5	3	710	General Office Building	100 tsf	1,101	155	126	19	149	25	124
				Subtotal	203.90 tsf	10,060	931	788	143	442	101	341
				Internal Capture (13% Daily, 4% AM, 16% PM)		-1,308	-37	-32	-5	-71	-16	-55
				Transit Trip Discount	5%	-503	-47	-39	-8	-22	-5	-17
				Total (less Internal/Transit Trips)		8,249	847	717	130	349	80	269
		3		Total w/ Internal/Transit & w/o Pass-by Trip Discount		21,744	1,445	978	467	1,507	680	827
		3		Total w/ Internal/Transit/Pass-by Trip Discount		20,291	1,445	978	467	1,385	620	765
Project Phase 2												
Single-Family	T3-1	4	210	Single-Family Detached Housing	39 du	373	29	7	22	39	25	14
Multi-Family	T4-5	4	230	Residential Condo/Townhouse	127 du	720	56	9	47	66	44	22
Multi-Family	T4-6	4	230	Residential Condo/Townhouse	94 du	546	41	7	34	49	33	16
Multi-Family	T3-1	4	230	Residential Condo/Townhouse	136 du	790	60	10	50	71	48	23
Long-term Care Facility	T3-2	4	620	Nursing Home	236 bed	559	40	28	12	52	17	35
Multi-Family	T3-3	4	230	Residential Condo/Townhouse	89 du	517	39	6	33	46	31	15
Multi-Family	T3-4	4	230	Residential Condo/Townhouse	260 du	1,511	114	18	96	135	91	44
Hospital/Medical Center	Hospital	4	610	Hospital	150 bed	1,772	171	122	49	197	71	126
Transit Station	T3-7	4	090	Park-and-Ride Lot with Bus Service	Accounted for in Parcel T5-10 (Phase 1, TAZ 3)							
Lodge	T3-7	4	310	Hotel	120 rm	900	67	41	26	71	37	34
Multi-Family	T3-7	4	230	Residential Condo/Townhouse	113 du	657	50	8	42	59	40	19
Retail	T3-7	4	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Office	T3-7	4	710	General Office Building	25 tsf	275	39	34	5	37	6	31
Multi-Family	T3-8	4	230	Residential Condo/Townhouse	374 du	2,173	165	26	139	194	131	63
Retail	T3-8	4	820	Shopping Center	45 tsf	1,932	45	27	18	168	82	86
Medical Office	T3-8	4	720	Medical-Dental Office Building	100 tsf	3,613	220	182	38	346	93	253
Multi-Family	T3-9	4	230	Residential Condo/Townhouse	359 du	2,086	158	25	133	187	126	61
Retail	T3-9	4	820	Shopping Center	100 tsf	4,294	100	61	39	373	183	190
Office	T3-9	4	710	General Office Building	75 tsf	826	116	102	14	112	19	93
Middle School	Middle School	4	522	Middle School/Junior High School	600 stu	972	324	180	144	96	48	48
TOD Park	P-2	4	412	County Park	13.10 ac	30	0	0	0	1	0	1
				Phase 2 Total without Trip Discounts		28,716	1,869	908	961	2,393	1,171	1,221

Table 3 (4 of 5) - Project Traffic Generation

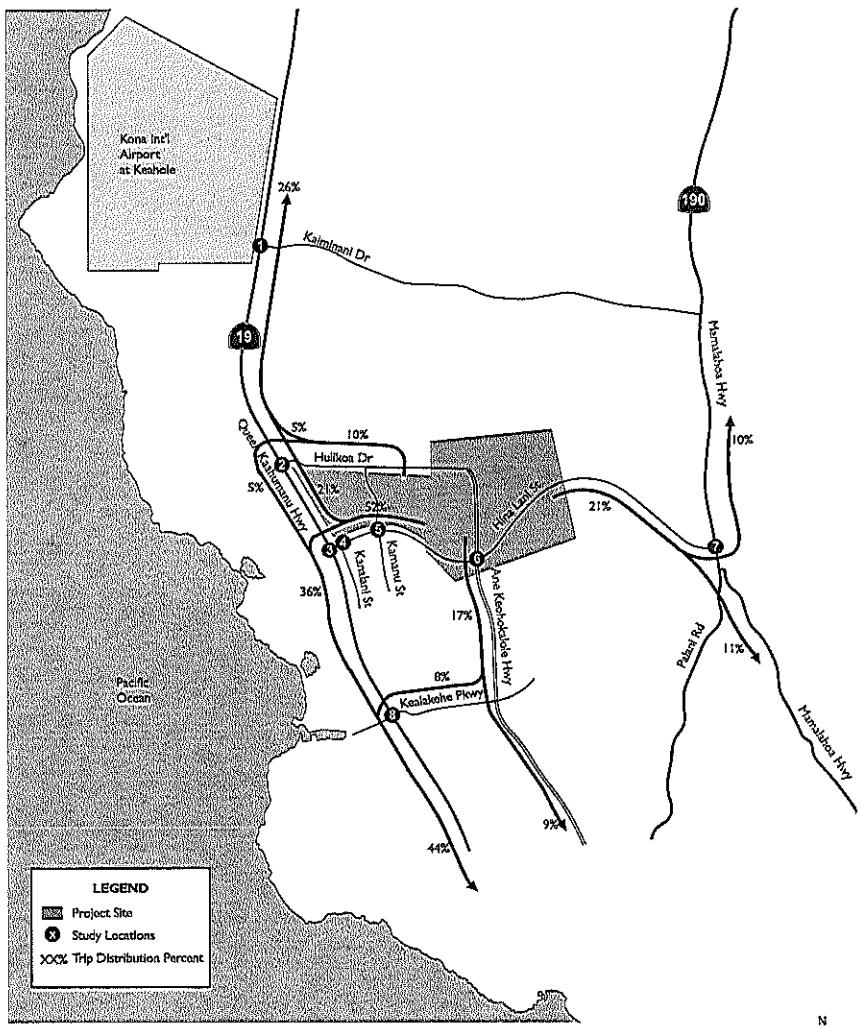
PROJECT TRAFFIC GENERATION

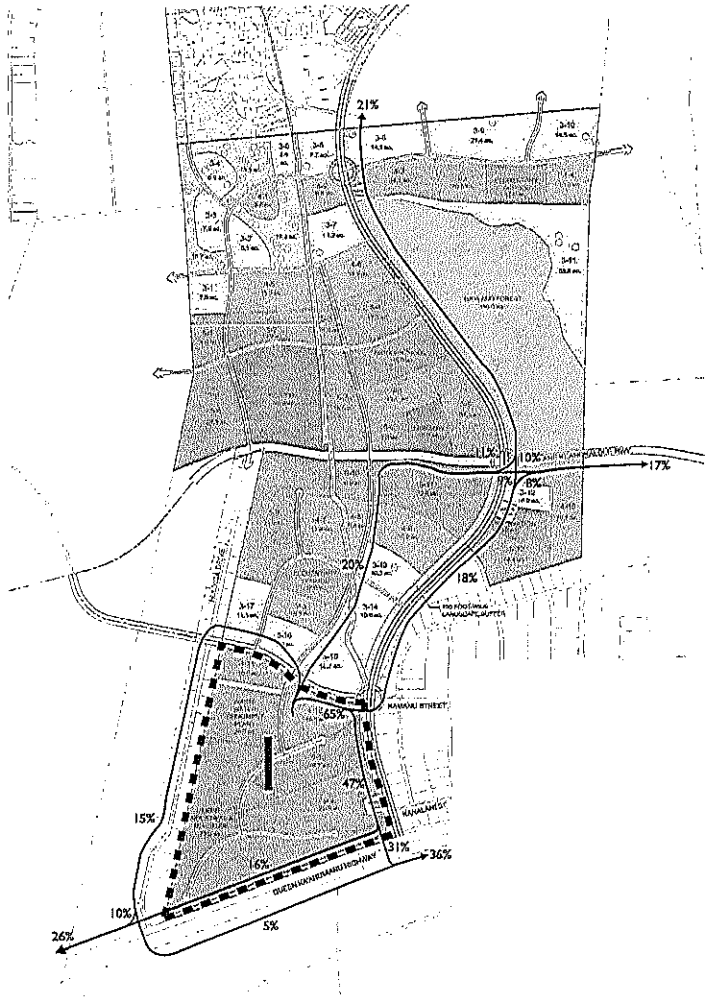
Project Description	Parcel I.D.	TAZ	ITE Code	ITE Description	Quantity / Unit	Daily	AM Total	AM In	AM Out	PM Total	PM In	PM Out
Phase 2, TAZ 4												
Single-Family	T3-1	4	210	Single-Family Detached Housing	39 du	373	29	7	22	39	25	14
Multi-Family	T4-5	4	230	Residential Condo/Townhouse	127 du	720	56	9	47	66	44	22
Multi-Family	T4-6	4	230	Residential Condo/Townhouse	94 du	546	41	7	34	49	33	16
Multi-Family	T3-1	4	230	Residential Condo/Townhouse	136 du	790	60	10	50	71	48	23
Multi-Family	T3-3	4	230	Residential Condo/Townhouse	89 du	517	39	6	33	46	31	15
Multi-Family	T3-4	4	230	Residential Condo/Townhouse	260 du	1,511	114	18	96	135	91	44
Multi-Family	T3-7	4	230	Residential Condo/Townhouse	113 du	657	50	8	42	59	40	19
Multi-Family	T3-8	4	230	Residential Condo/Townhouse	374 du	2,173	165	26	139	194	131	63
Multi-Family	T3-9	4	230	Residential Condo/Townhouse	359 du	2,086	158	25	133	187	126	61
				Subtotal	1,591 du	9,391	712	116	596	846	569	277
				Internal Capture (12% Daily, 4% AM, 9% PM)		-1,127	-28	-5	-23	-76	-51	-25
				Transit Trip Discount	5%	-470	-36	-6	-30	-42	-28	-14
				Total (less Internal/Transit Trips)		7,794	648	105	543	728	490	238
Retail	T3-7	4	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Retail	T3-8	4	820	Shopping Center	45 tsf	1,932	45	27	18	168	82	86
Retail	T3-9	4	820	Shopping Center	100 tsf	4,294	100	61	39	373	183	190
				Subtotal	170 tsf	7,300	170	103	67	634	311	323
				Internal Capture (12% Daily, 4% AM, 9% PM)		-876	-7	-4	-3	-57	-28	-29
				Transit Trip Discount	5%	-365	-9	-5	-4	-32	-16	-16
				Total (less Internal/Transit Trips)		6,059	154	94	60	545	267	278
				Pass-by Trip Discount	15%	-909	0	0	0	-82	-40	-42
				Total (less Internal/Transit/Pass-by Trips)		5,150	154	94	60	463	227	236
Hospital/Medical Center	Hospital	4	610	Hospital	150 bed	1,772	171	122	49	197	71	126
Office	T3-7	4	710	General Office Building	25 tsf	275	39	34	5	37	6	31
Medical Office	T3-8	4	720	Medical-Dental Office Building	100 tsf	3,613	220	182	38	346	93	253
Office	T3-9	4	710	General Office Building	75 tsf	826	116	102	14	112	19	93
Lodge	T3-7	4	310	Hotel	120 rm	900	67	41	26	71	37	34
				Subtotal		7,466	623	481	142	763	226	537
				Internal Capture (12% Daily, 4% AM, 9% PM)		-896	-25	-19	-6	-69	-20	-49
				Transit Trip Discount	5%	-373	-31	-24	-7	-38	-11	-27
				Total (less Internal/Transit Trips)		6,197	567	438	129	656	195	461
Long-term Care Facility	T3-2	4	620	Nursing Home	236 bed	559	40	28	12	52	17	35
Transit Station	T3-7	4	090	Park-and-Ride Lot with Bus Service	Accounted for in Parcel T5-10 (Phase 1, TAZ 3)							
Middle School	Middle School	4	522	Middle School/Junior High School	600 stu	972	324	180	144	96	48	48
TOD Park	P-2	4	412	County Park	13.10 ac	30	0	0	0	1	0	1
		4		Total w/ Internal/Transit & w/o Pass-by Trip Discount		21,611	1,733	845	888	2,076	1,017	1,061
		4		Total w/ Internal/Transit/Pass-by Trip Discount		20,707	1,733	845	888	1,996	977	1,019
Project Phase 3												
Single-Family	T3-2	5	210	Single-Family Detached Housing	32 du	306	24	6	18	32	20	12
Single-Family	T3-3	5	210	Single-Family Detached Housing	24 du	230	18	5	13	24	15	9
Single-Family	T3-4	5	210	Single-Family Detached Housing	20 du	191	15	4	11	20	13	7
Single-Family	T3-5	5	210	Single-Family Detached Housing	18 du	172	14	3	11	18	12	6
Single-Family	T3-6	5	210	Single-Family Detached Housing	31 du	297	23	6	17	31	20	11
Single-Family	T3-7	5	210	Single-Family Detached Housing	45 du	431	34	9	25	45	29	16
Single-Family	T3-8	6	210	Single-Family Detached Housing	56 du	536	42	11	31	57	36	21
Single-Family	T3-9	6	210	Single-Family Detached Housing	86 du	823	65	16	49	87	55	32
Single-Family	T3-10	6	210	Single-Family Detached Housing	58 du	555	44	11	33	59	37	22
Single-Family	T3-11	6	210	Single-Family Detached Housing	155 du	1,480	116	29	87	157	99	58
Multi-Family	T4-1	5	230	Residential Condo/Townhouse	37 du	215	16	3	13	19	13	6
Multi-Family	T4-2	5	230	Residential Condo/Townhouse	46 du	267	20	3	17	24	16	8
Multi-Family	T4-3	6	230	Residential Condo/Townhouse	99 du	575	44	7	37	51	35	16
Retail	T4-3	6	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Multi-Family	T4-4	6	230	Residential Condo/Townhouse	70 du	407	31	5	26	36	25	11
TOD Park	P-1	6	412	County Park	10.00 ac	23	0	0	0	1	0	1
Elementary School	Elem School	6	520	Elementary School	450 stu	581	203	113	90	68	32	36
MF Affordable Senior	T4-10	7	252	Senior Adult Housing-Attached	141 du	491	18	7	11	23	14	9
Retail	T4-10	7	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Single-Family	T3-12	7	210	Single-Family Detached Housing	35 du	335	26	7	19	35	22	13
Fire Station/Police Sub-station	Fire Station	7	730	Government Office Building	3 ac	207	18	15	3	4	1	3
MF Affordable	T5-12	7	220	Apartment	282 du	1,875	144	28	116	175	113	62
Retail	T5-12	7	820	Shopping Center	25 tsf	1,074	25	15	10	93	46	47
Office	T5-12	7	710	General Office Building	25 tsf	275	39	34	5	37	6	31
				Phase 3 Total without Trip Discounts		13,497	1,029	367	662	1,262	751	511

Table 3 (5 of 5) - Project Traffic Generation

PROJECT TRAFFIC GENERATION

Project Description	Parcel I.D.	TAZ	ITE Code	ITE Description	Quantity / Unit	Daily	AM Total	AM In	AM Out	PM Total	PM In	PM Out
Phase 3, TAZ 5												
Single-Family	T3-2	5	210	Single-Family Detached Housing	32 du	306	24	6	18	32	20	12
Single-Family	T3-3	5	210	Single-Family Detached Housing	24 du	230	18	5	12	24	15	9
Single-Family	T3-4	5	210	Single-Family Detached Housing	20 du	191	15	4	11	20	13	7
Single-Family	T3-5	5	210	Single-Family Detached Housing	18 du	172	14	3	11	18	12	6
Single-Family	T3-6	5	210	Single-Family Detached Housing	31 du	297	23	6	17	31	20	11
Single-Family	T3-7	5	210	Single-Family Detached Housing	45 du	431	34	9	25	45	29	16
Multi-Family	T4-1	5	230	Residential Condo/Townhouse	37 du	213	16	3	13	19	13	6
Multi-Family	T4-2	5	230	Residential Condo/Townhouse	46 du	267	20	3	17	24	16	8
		5		Total w/o Trip Discounts		2,109	164	39	125	213	138	75
Phase 3, TAZ 6												
Single-Family	T3-8	6	210	Single-Family Detached Housing	56 du	536	42	11	31	57	36	21
Single-Family	T3-9	6	210	Single-Family Detached Housing	86 du	823	65	16	49	87	55	32
Single-Family	T3-10	6	210	Single-Family Detached Housing	58 du	555	44	11	33	59	37	22
Single-Family	T3-11	6	210	Single-Family Detached Housing	155 du	1,480	116	29	87	157	99	58
Multi-Family	T4-3	6	230	Residential Condo/Townhouse	99 du	575	44	7	37	51	35	16
Multi-Family	T4-4	6	230	Residential Condo/Townhouse	70 du	407	31	5	26	36	25	11
				Subtotal	524 du	4,379	342	79	263	447	287	160
				Internal Capture (4% Daily, 1% AM, 4% PM)		-175	-3	-1	-2	-18	-11	-7
				Transit Trip Discount	5%	-219	-17	-4	-13	-22	-14	-8
				Total (less Internal/Transit Trips)		3,985	322	74	248	407	262	145
Retail	T4-3	6	820	Shopping Center	25 ksf	1,074	25	15	10	93	46	47
				Internal Capture (4% Daily, 1% AM, 4% PM)		-43	0	0	0	-4	-2	-2
				Transit Trip Discount	5%	-54	-1	-1	0	-5	-2	-3
				Total (less Internal/Transit Trips)		977	24	14	10	84	42	42
				Pass-by Trip Discount	15%	-147	0	0	0	-13	-6	-7
				Total (less Internal/Transit/Pass-by Trips)		830	24	14	10	71	36	35
TOD Park	P-1	6	412	County Park	10 ac	23	0	0	0	1	0	1
Elementary School	Elem School	6	520	Elementary School	450 stu	581	203	113	90	68	32	36
		6		Total w/ Internal/Transit & w/o Pass-by Trip Discount		5,366	549	201	348	560	336	224
		6		Total w/ Internal/Transit/Pass-by Trip Discount		5,419	549	201	348	547	330	217
Phase 3, TAZ 7												
MF Affordable Senior	T4-10	7	252	Senior Adult Housing-Attached	141 du	491	18	7	11	23	14	9
Single-Family	T3-12	7	210	Single-Family Detached Housing	35 du	335	26	7	19	35	22	13
MF Affordable	T5-12	7	220	Apartment	282 du	1,875	144	28	116	175	113	62
				Subtotal	458 du	2,701	188	42	146	233	149	84
				Internal Capture (11% Daily, 4% AM, 10% PM)		-297	-8	-2	-6	-23	-15	-8
				Transit Trip Discount	5%	-135	-9	-2	-7	-12	-7	-5
				Total (less Internal/Transit Trips)		2,269	171	39	133	198	127	71
Retail	T4-10	7	820	Shopping Center	25 ksf	1,074	25	15	10	93	46	47
Retail	T5-12	7	820	Shopping Center	25 ksf	1,074	25	15	10	93	46	47
				Subtotal	50 ksf	2,148	50	30	20	186	92	94
				Internal Capture (11% Daily, 4% AM, 10% PM)		-236	-2	-1	-1	-19	-9	-10
				Transit Trip Discount	5%	-107	-2	-2	-1	-9	-5	-4
				Total (less Internal/Transit Trips)		1,805	45	27	18	158	78	80
				Pass-by Trip Discount	15%	-271	0	0	0	-24	-12	-12
				Total (less Internal/Transit/Pass-by Trips)		1,534	45	27	18	134	66	68
Fire Station/Police Sub-station	Fire Station	7	730	Government Office Building	3 ac	207	18	15	3	4	1	3
Office	T5-12	7	710	General Office Building	25 ksf	275	39	34	5	37	6	31
				Subtotal		482	57	49	8	41	7	34
				Internal Capture (11% Daily, 4% AM, 10% PM)		-53	-2	-2	0	-4	-1	-3
				Transit Trip Discount	5%	-24	-3	-2	-1	-2	0	-2
				Total (less Internal/Transit Trips)		405	52	45	7	35	6	29
		7		Total w/ Internal/Transit & w/o Pass-by Trip Discount		4,479	268	110	158	391	211	180
		7		Total w/ Internal/Transit/Pass-by Trip Discount		4,208	268	110	158	367	199	168
				Trip Generation								
				Phases 1, 2, 3 without Discounts		80,015	6,129	3,261	2,868	7,415	3,611	3,804
				Phases 1, 2, 3 w/ Internal/Transit Discounts		70,923	5,702	3,034	2,668	6,414	3,129	3,285
						89%	93%	93%	93%	87%	87%	86%
				Phases 1, 2, 3 w/ Internal/Transit/Pass-by Discounts		67,666	5,702	3,034	2,668	6,131	2,990	3,141
						82%	93%	93%	93%	83%	83%	83%





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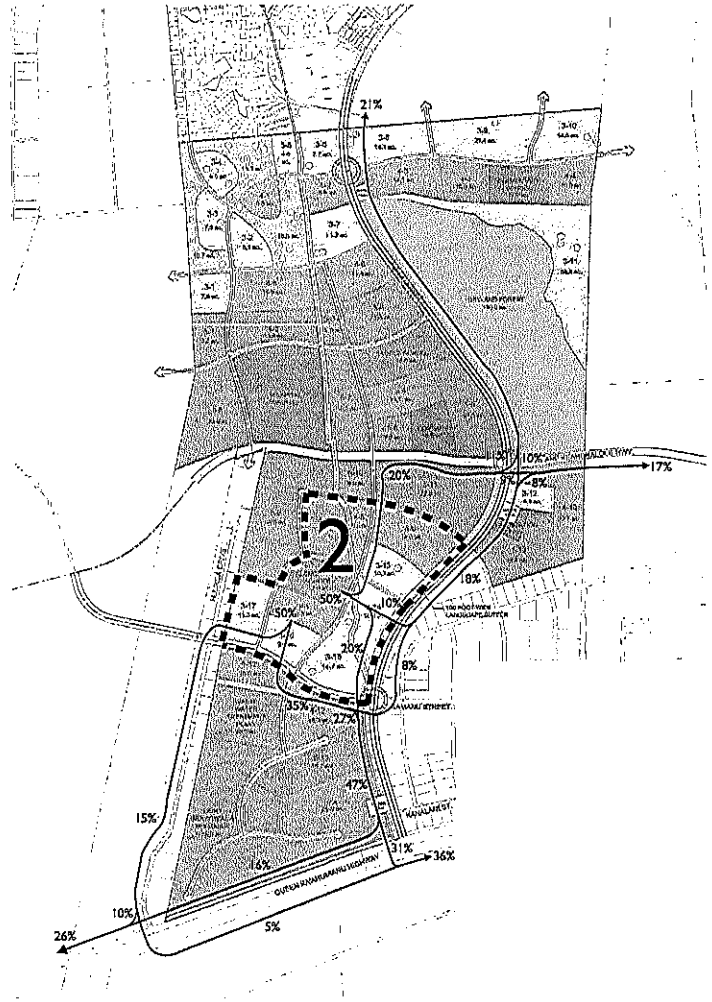
Kona, Hawaii — Figure 5

Kaloko Makai Project — Project TAZ 1 Trip Distribution



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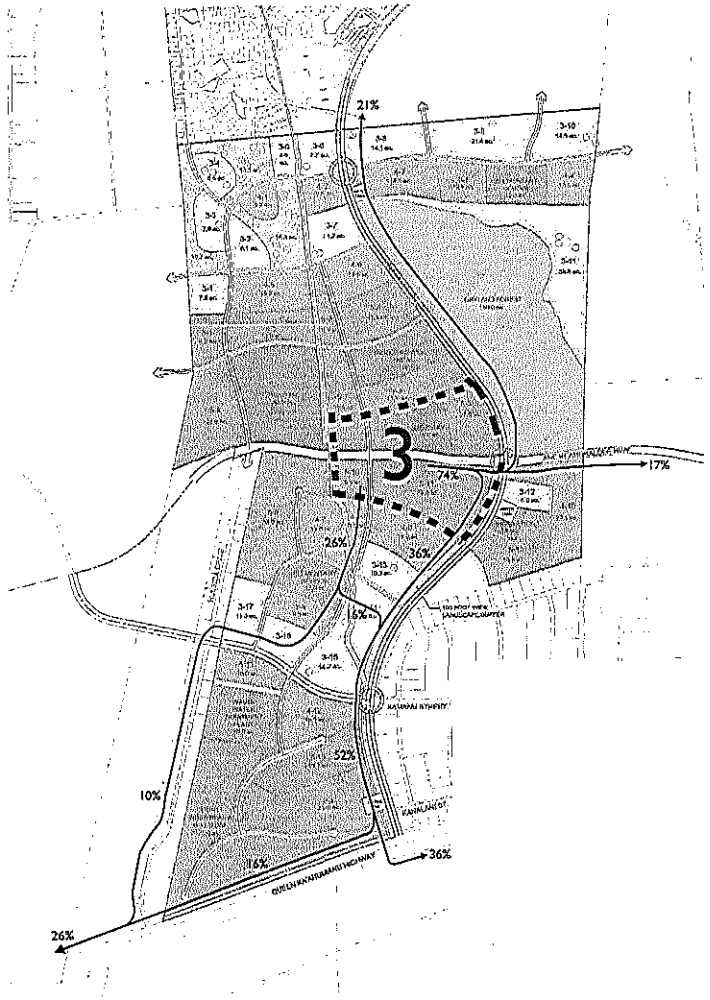
Kona, Hawaii — Figure 6

Kaloko Makai Project — Project TAZ 2 Trip Distribution



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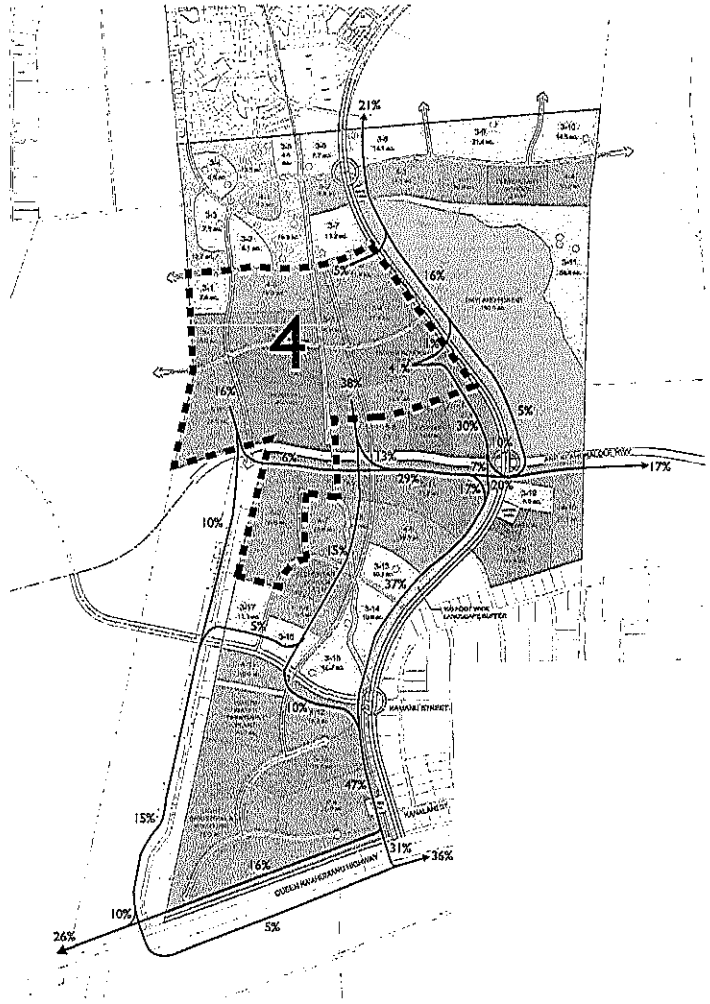
Kona, Hawaii — Figure 7

Kaloko Makai Project — Project TAZ 3 Trip Distribution



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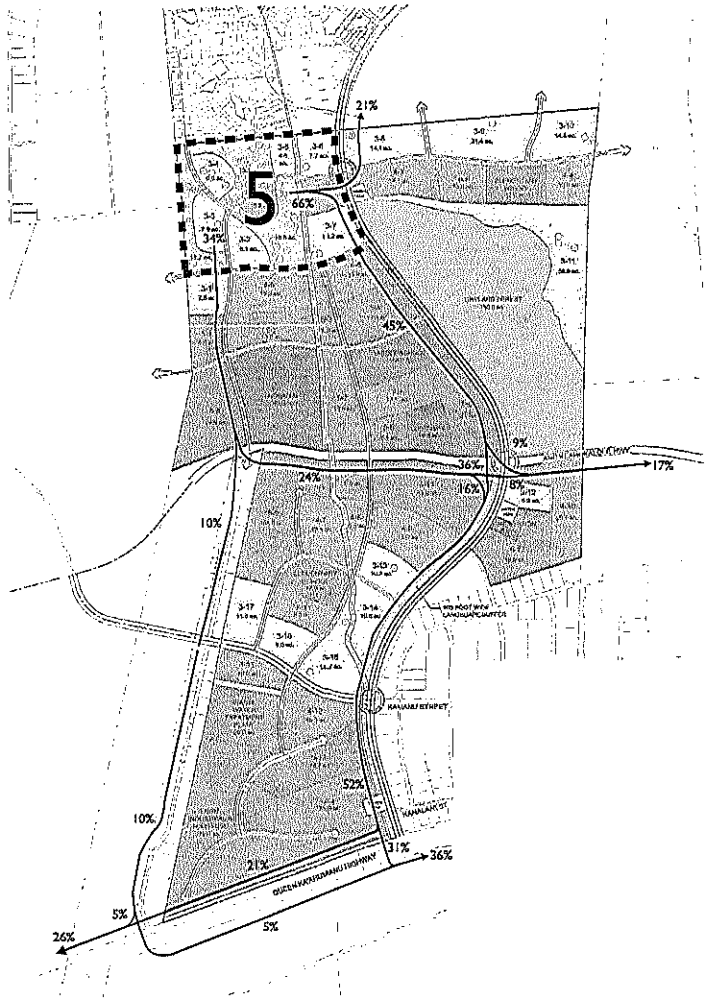
Kona, Hawaii — Figure 8

Kaloko Makai Project — Project TAZ 4 Trip Distribution



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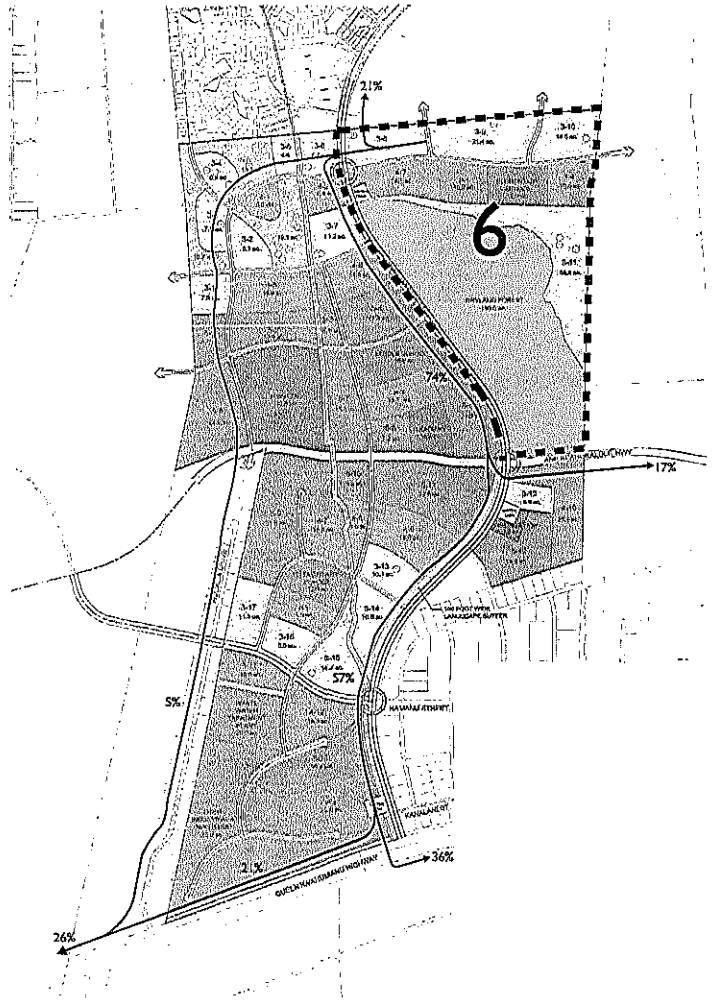
Kona, Hawaii — Figure 9

Kaloko Makai Project — Project TAZ 5 Trip Distribution



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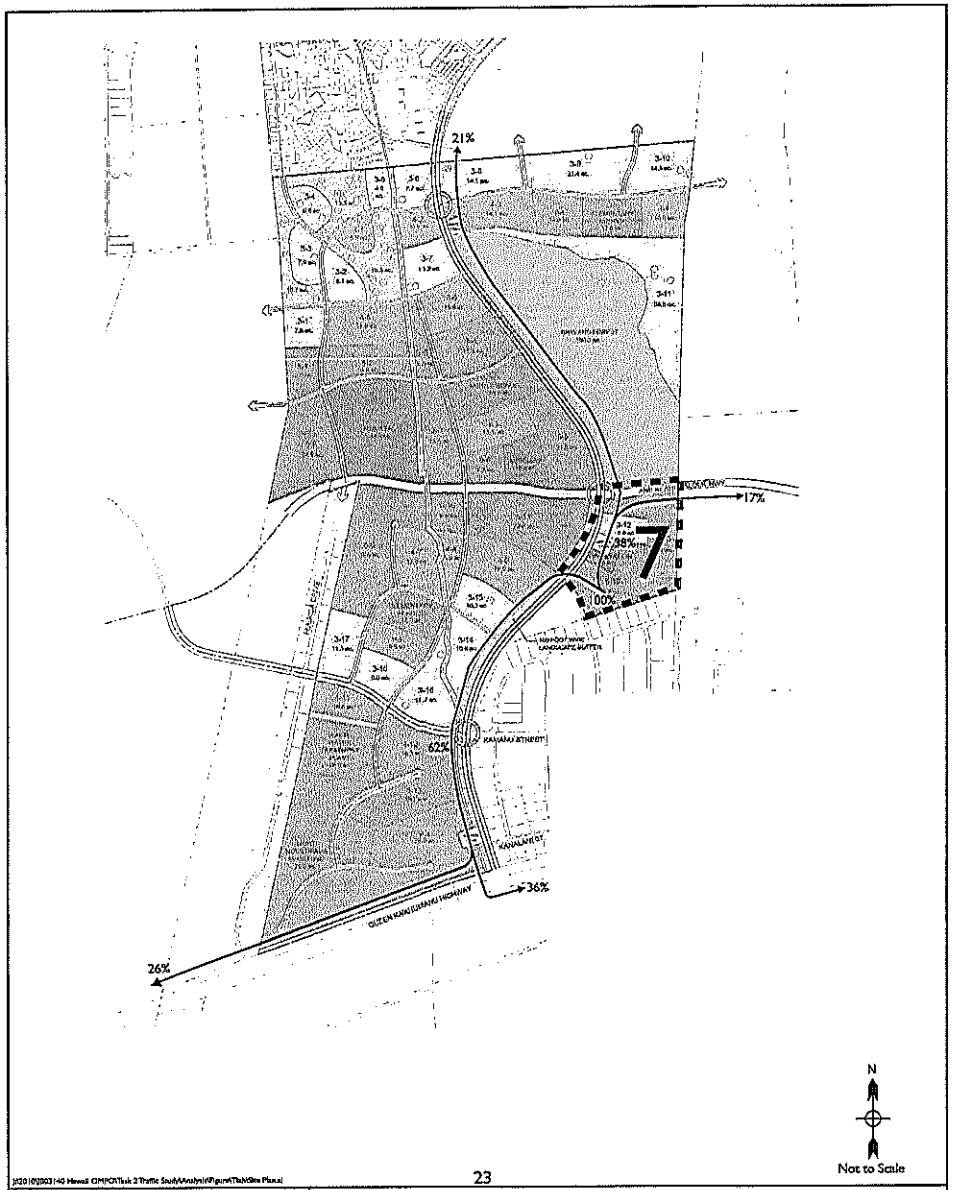
Kona, Hawaii — Figure 10

Kaloko Makai Project — Project TAZ 6 Trip Distribution



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Kona, Hawaii — Figure 11
Kaloko Makai Project — Project TAZ 7 Trip Distribution

- Table 4 and Figure 12: Total Project Phase 1 Traffic
- Table 5 and Figure 13: Total Project Phase 2 Traffic
- Table 6 and Figure 14: Total Project Phase 3 Traffic

3.8 Other Cumulative Development Traffic

Future traffic increases consider additional traffic that are generated by other cumulative developments that either is under construction, approved, planned, or proposed for development near the study area based on available information obtained by the project team. Estimated trips from the cumulative developments have been assigned to the study area roadway system based on their anticipated travel patterns. This study includes the following 5 other cumulative developments in the vicinity of the project site to determine future traffic projections, as shown on Figure 15:

- Kaloko Heights – 300 dwelling units of single-family detached housing
- Kule Nei – 270 dwelling units of single-family detached housing
- West Hawaii Business Park – Mixed use development
- Kohanaiki Business Park – A business park development
- Kaloko Industrial Park Phases 3 (2015) and Phase 4 (2025) – A100-acre industrial park.

The cumulative development trip generation summary is shown on Table 7. The trip distribution patterns for the cumulative developments are shown on Figures 16 through 20. It should be noted that although there may be other projects planned in the Kona region, the development plan and implementation schedule for these projects is not known at this time. As such, for the purpose of this report, the cumulative effect of these other future projects is assumed to be captured by ambient growth in traffic in the vicinity.

3.9 Ambient Background Growth

In addition to cumulative development traffic, other unidentified projects and general population growth contribute to ambient background traffic growth. Ambient growth is calculated as an annual growth percentage increase from existing traffic count volumes.

Based on a comparison of the 2007 and 2010 traffic count data for the intersection of Queen Ka'ahumanu Highway at Hina Lani Street, the total PM peak hour intersection traffic volumes experienced an increase from 2,551 vehicles to 2,773 vehicles which is a 3-year total growth of 8.7% or an annual growth rate of 2.8%. Available traffic data and other similar traffic studies in the surrounding area have been reviewed, and it appears that an annual growth rate of 2.8% may be conservatively high but it is fairly comparable and consistent to other available data. Therefore, this study utilizes a conservatively-high 2.8% ambient growth rate to assess future traffic conditions. The cumulative percentage increase in ambient growth projected to occur over the 3 analysis horizon years are as follow:

Table 4 - Phase 1 Project-Only Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kaiminani Dr.	AM	0	299	0	0	478	0	0	0	0	0	0	0	777
		PM	0	432	0	0	350	0	0	0	0	0	0	0	782
2	Queen Kaahumanu Hwy./Hulikoa Dr.	AM	0	184	43	184	294	0	0	0	0	34	0	115	854
		PM	0	266	36	135	215	0	0	0	0	45	0	166	863
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	43	619	294	34	0	0	0	0	380	0	184	1,554
		PM	0	36	448	215	45	0	0	0	0	553	0	266	1,563
4	Kanalani St./ Hina Lani St.	AM	0	0	0	0	0	0	0	913	0	0	563	0	1,476
		PM	0	0	0	0	0	0	0	664	0	0	819	0	1,483
5	Kamanu St./ Hina Lani St.	AM	0	0	0	87	0	249	346	567	0	0	315	126	1,690
		PM	0	0	0	130	0	358	268	395	0	0	462	94	1,707
6	Ane Keohokalole Hwy./Hina Lani St.	AM	69	244	0	173	141	168	352	68	55	0	86	300	1,656
		PM	58	171	0	259	211	275	223	90	72	0	73	210	1,642
7	Mamalahoa Hwy./ Hina Lani St.	AM	202	0	0	0	0	184	115	0	126	0	0	0	627
		PM	148	0	0	0	0	135	166	0	183	0	0	0	632
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	0	662	147	0	414	0	0	0	0	92	0	0	1,315
		PM	0	485	108	0	598	0	0	0	0	133	0	0	1,324

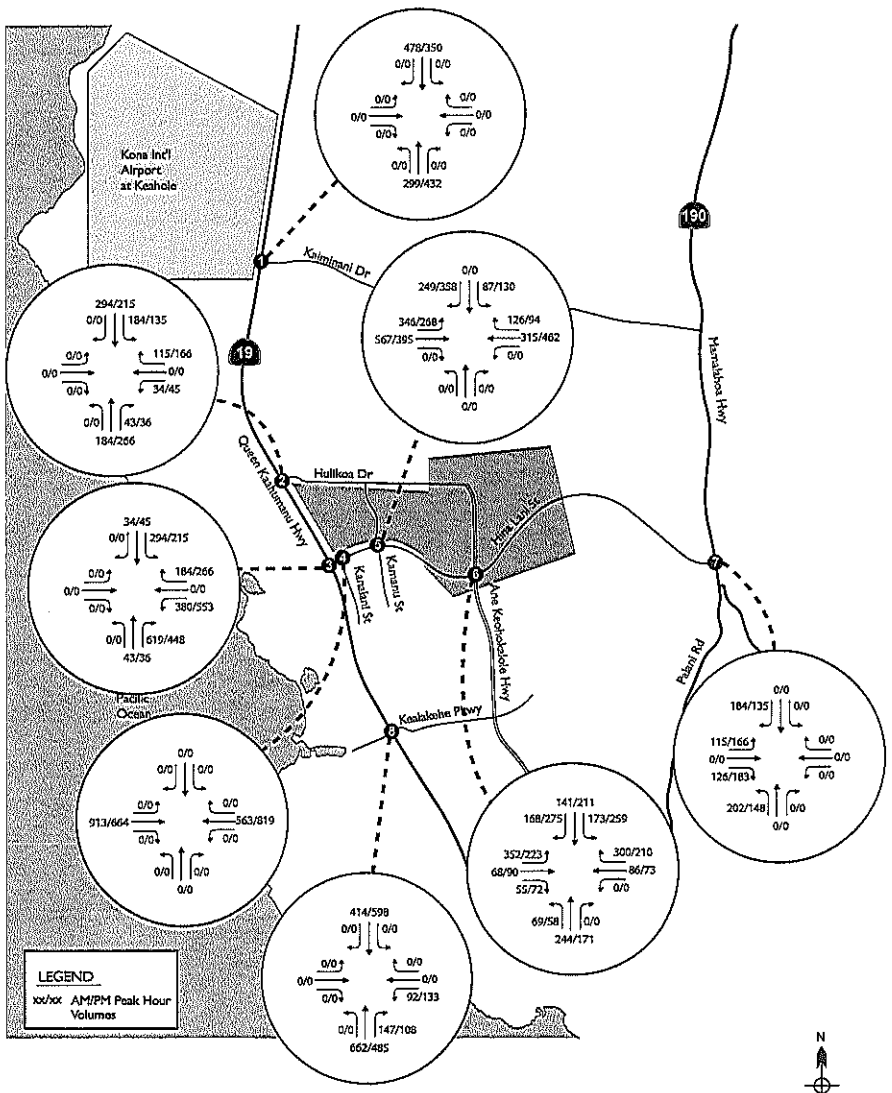


Table 5 - Phase 2 Project-Only Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kaiminani Dr.	AM	0	530	0	0	698	0	0	0	0	0	0	0	1,228
		PM	0	697	0	0	604	0	0	0	0	0	0	0	1,301
2	Queen Kaahumanu Hwy./Huilkoa Dr.	AM	0	326	85	268	429	0	0	0	0	78	0	204	1,390
		PM	0	429	85	232	372	0	0	0	0	96	0	268	1,482
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	85	881	429	78	0	0	0	0	655	0	326	2,454
		PM	0	85	751	372	96	0	0	0	0	869	0	429	2,602
4	Kanalani St./ Hina Lani St.	AM	0	0	0	0	0	0	0	1,310	0	0	981	0	2,291
		PM	0	0	0	0	0	0	0	1,123	0	0	1,298	0	2,421
5	Kamanu St./ Hina Lani St.	AM	0	0	0	87	0	337	430	880	0	0	643	126	2,503
		PM	0	0	0	130	0	460	366	757	0	0	839	94	2,646
6	Ane Keohuokalole Hwy./Hina Lani St.	AM	69	303	84	217	203	319	496	237	55	89	264	342	2,678
		PM	58	239	98	310	282	449	389	285	72	102	276	259	2,819
7	Mamalahoa Hwy./ Hina Lani St.	AM	295	0	0	0	0	268	204	0	224	0	0	0	991
		PM	256	0	0	0	0	232	268	0	295	0	0	0	1,051
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	0	966	215	0	733	0	0	0	0	163	0	0	2,077
		PM	0	836	186	0	965	0	0	0	0	214	0	0	2,201

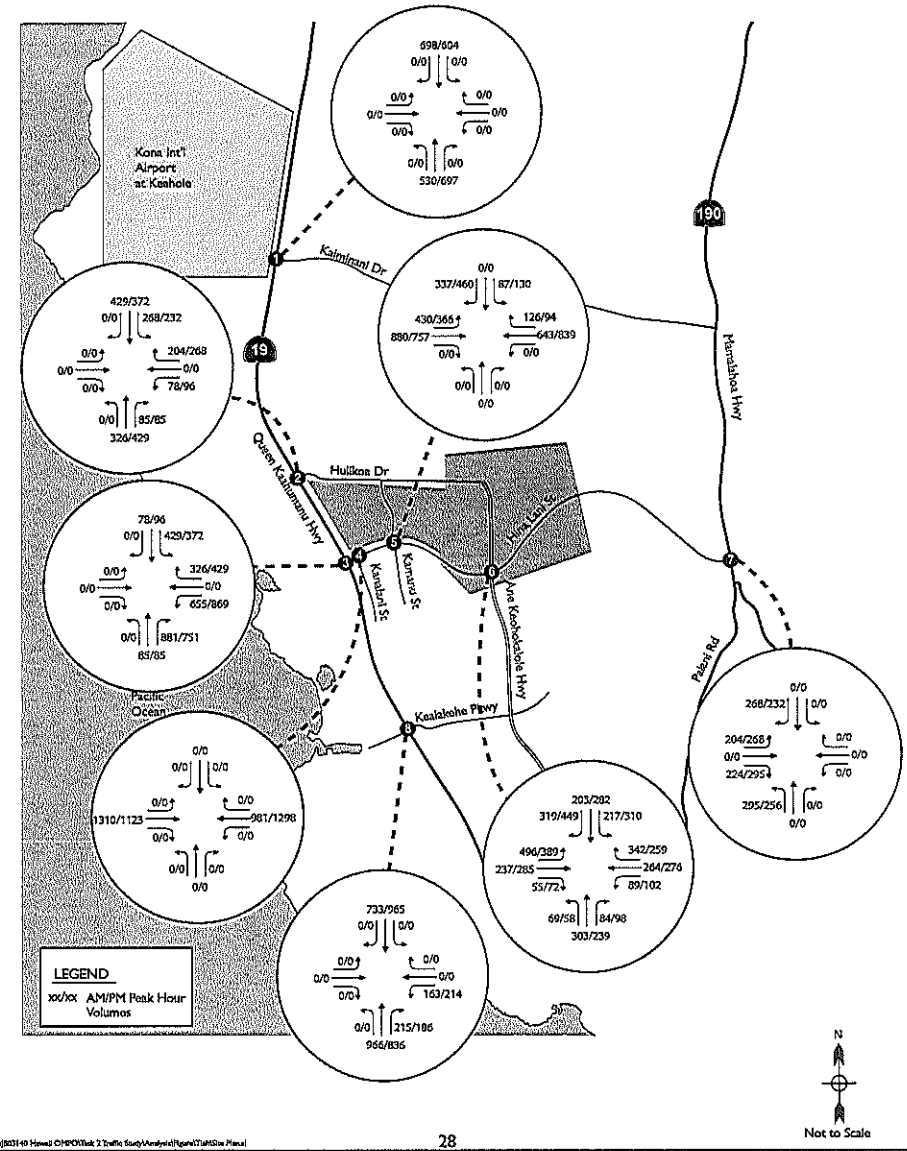
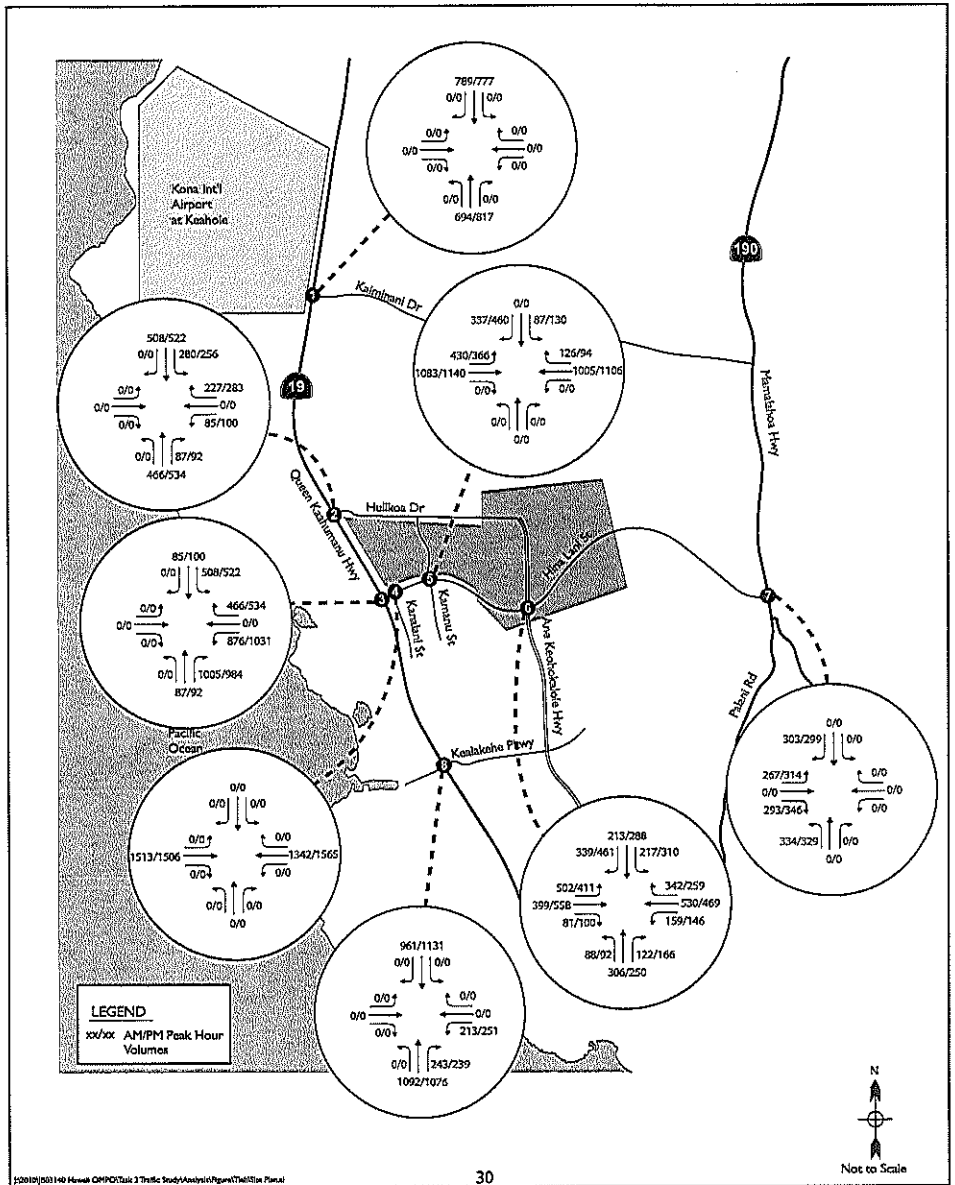
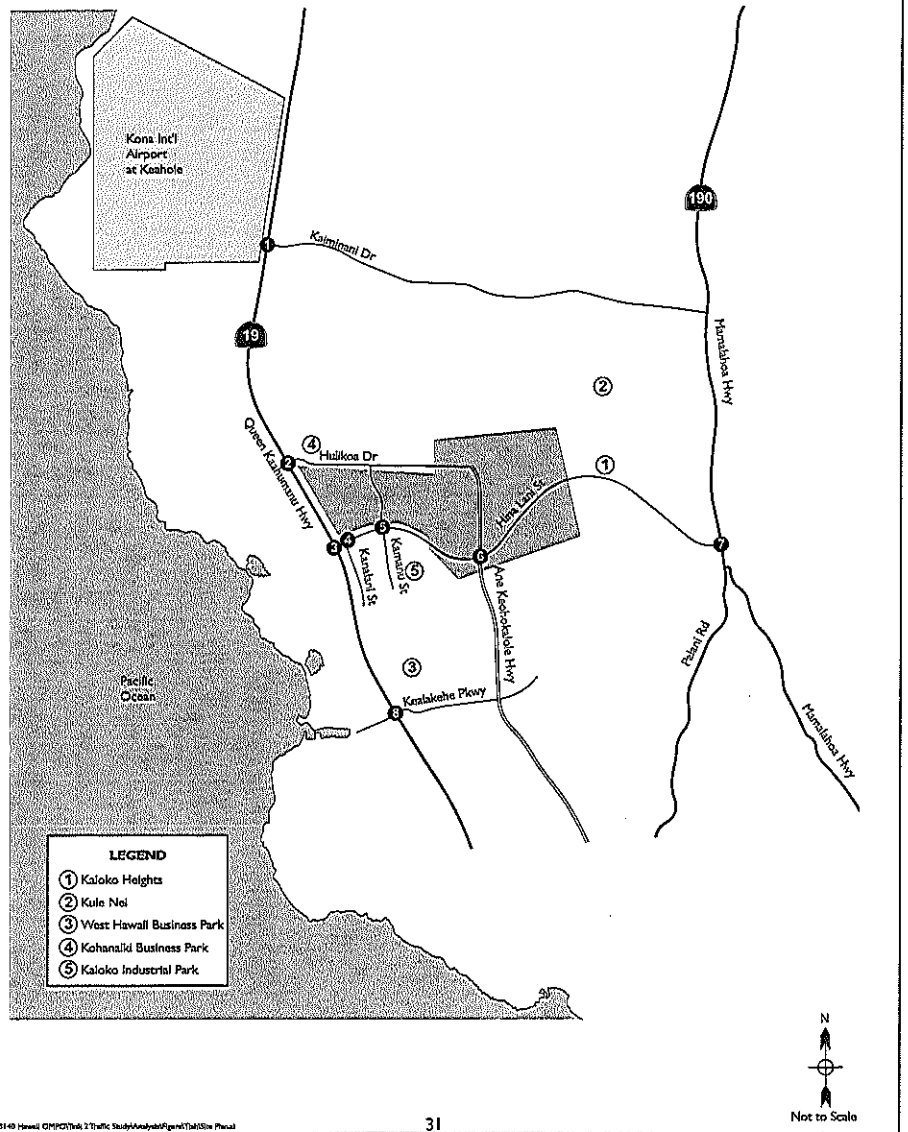


Table 6 - Phase 3 Project-Only Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kaiminani Dr.	AM	0	694	0	0	789	0	0	0	0	0	0	0	1,483
		PM	0	817	0	0	777	0	0	0	0	0	0	0	1,594
2	Queen Kaahumanu Hwy./Hulikoa Dr.	AM	0	466	87	280	508	0	0	0	0	85	0	227	1,653
		PM	0	534	92	256	522	0	0	0	0	100	0	283	1,787
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	87	1,005	508	85	0	0	0	0	876	0	466	3,027
		PM	0	92	984	522	100	0	0	0	0	1,031	0	534	3,263
4	Kanalani St./ Hina Lani St.	AM	0	0	0	0	0	0	0	1,513	0	0	1,342	0	2,855
		PM	0	0	0	0	0	0	0	1,506	0	0	1,565	0	3,071
5	Kamanu St./ Hina Lani St.	AM	0	0	0	87	0	337	430	1,083	0	0	1,005	126	3,068
		PM	0	0	0	130	0	460	366	1,140	0	0	1,106	94	3,296
6	Ane Keohokalole Hwy./Hina Lani St.	AM	88	306	122	217	213	339	502	399	81	159	530	342	3,298
		PM	92	250	166	310	288	461	411	558	100	146	469	259	3,510
7	Mamalahoa Hwy./ Hina Lani St.	AM	334	0	0	0	0	303	267	0	293	0	0	0	1,197
		PM	329	0	0	0	0	299	314	0	346	0	0	0	1,288
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	0	1,092	243	0	961	0	0	0	0	213	0	0	2,509
		PM	0	1,076	239	0	1,131	0	0	0	0	251	0	0	2,697





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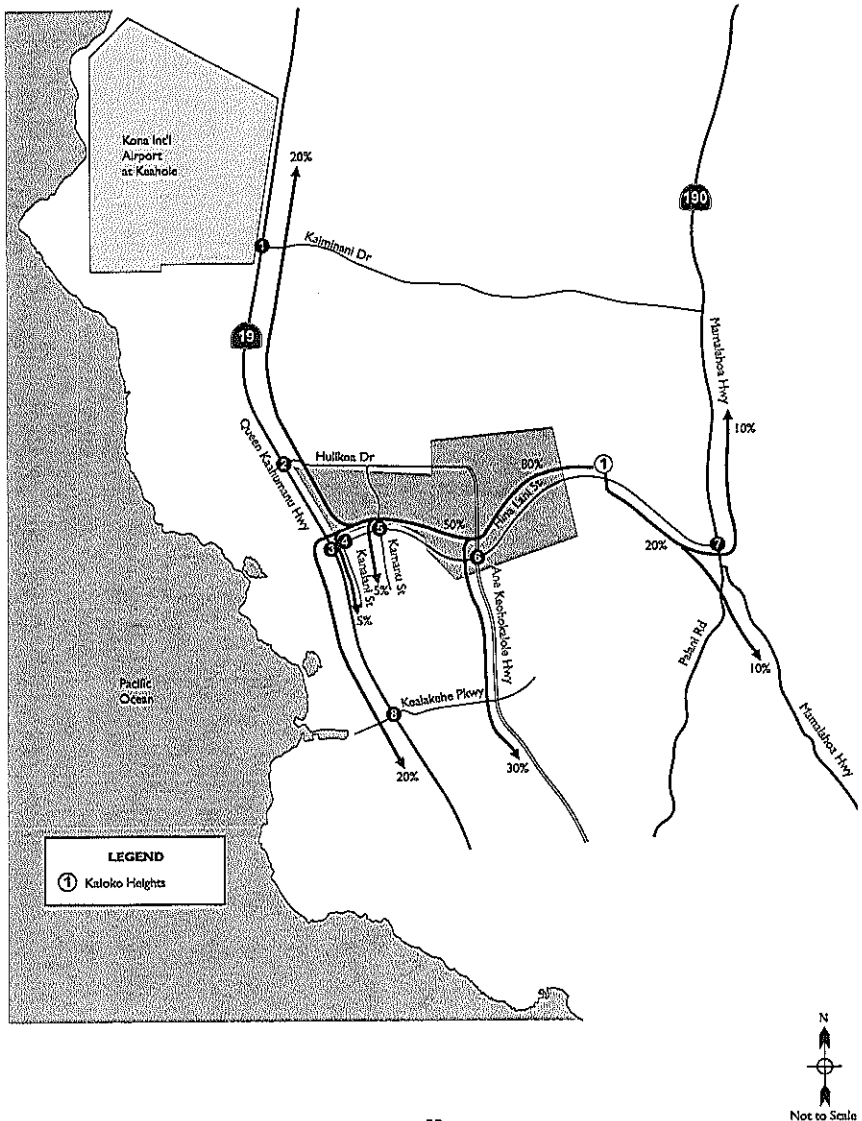
Kona, Hawaii — Figure 15

Kaloko Makai Project — Other Cumulative Development Locations

Table 7 - Other Cumulative Development Traffic Generation

No.	Name	Year	Land Use	Quantity	Daily Trips	AM Peak Hour			PM Peak Hour		
						Total	In	Out	Total	In	Out
1	Kaloko Heights	2015	Single-Family Housing	300 DU	2,871	225	57	168	303	192	111
2	Kula Nei	2015	Single-Family Housing	270 DU	2,584	202	51	151	273	173	100
3	West Hawaii Business Park	2015	Mixed-Use	n/a	22,691	1,098	822	276	2,294	911	1,383
4	Kohanaiki Business Park	2015	Business Park	n/a	1,197	146	81	65	121	52	69
5	Kaloko Industrial Park	2015	Industrial Park	37.3 AC	2,354	319	265	54	329	69	260
	Kaloko Industrial Park	2025	Industrial Park	60.7 AC	3,831	519	431	88	537	113	424
Total Cumulative 2015 Traffic					31,697	1,990	1,276	714	3,320	1,397	1,923
Total Cumulative 2025 Traffic					35,528	2,509	1,707	802	3,857	1,510	2,347



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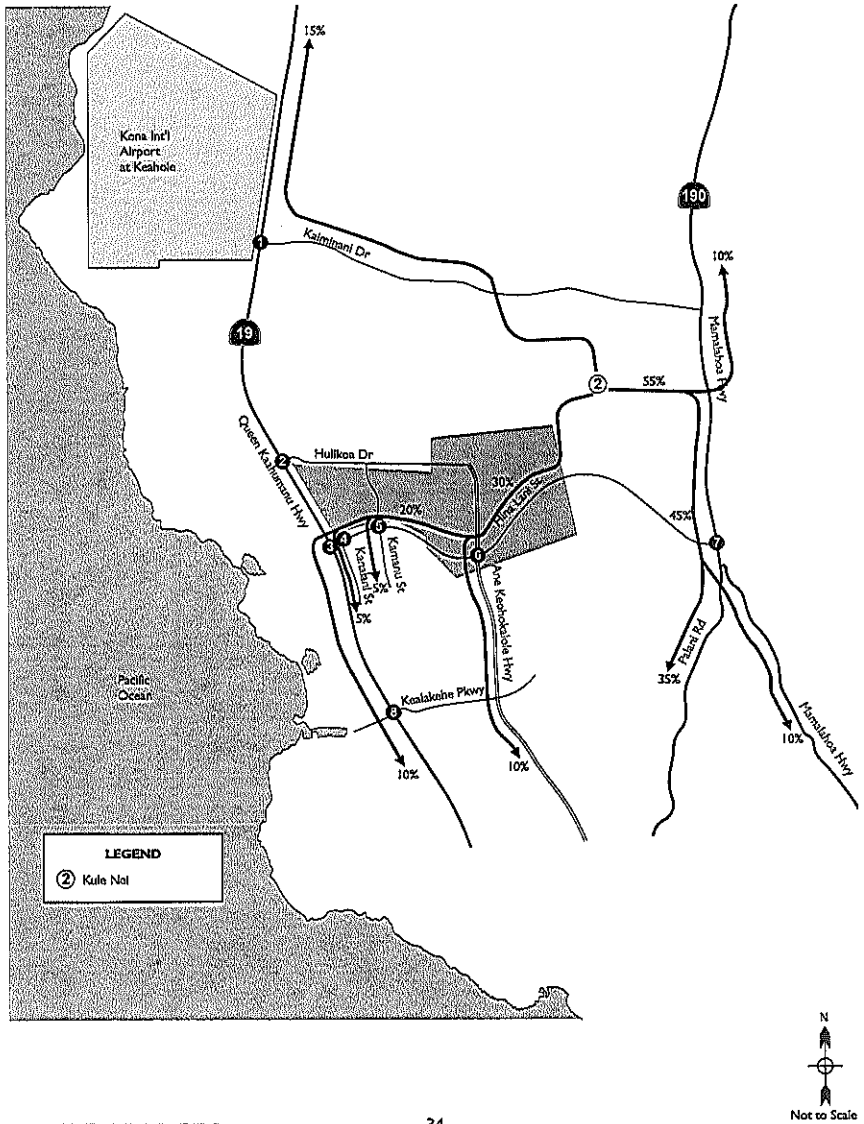
Kona, Hawaii — Figure 16

Kaloko Makai Project — Other Cumulative Development Trip Distribution-Kaloko Heights



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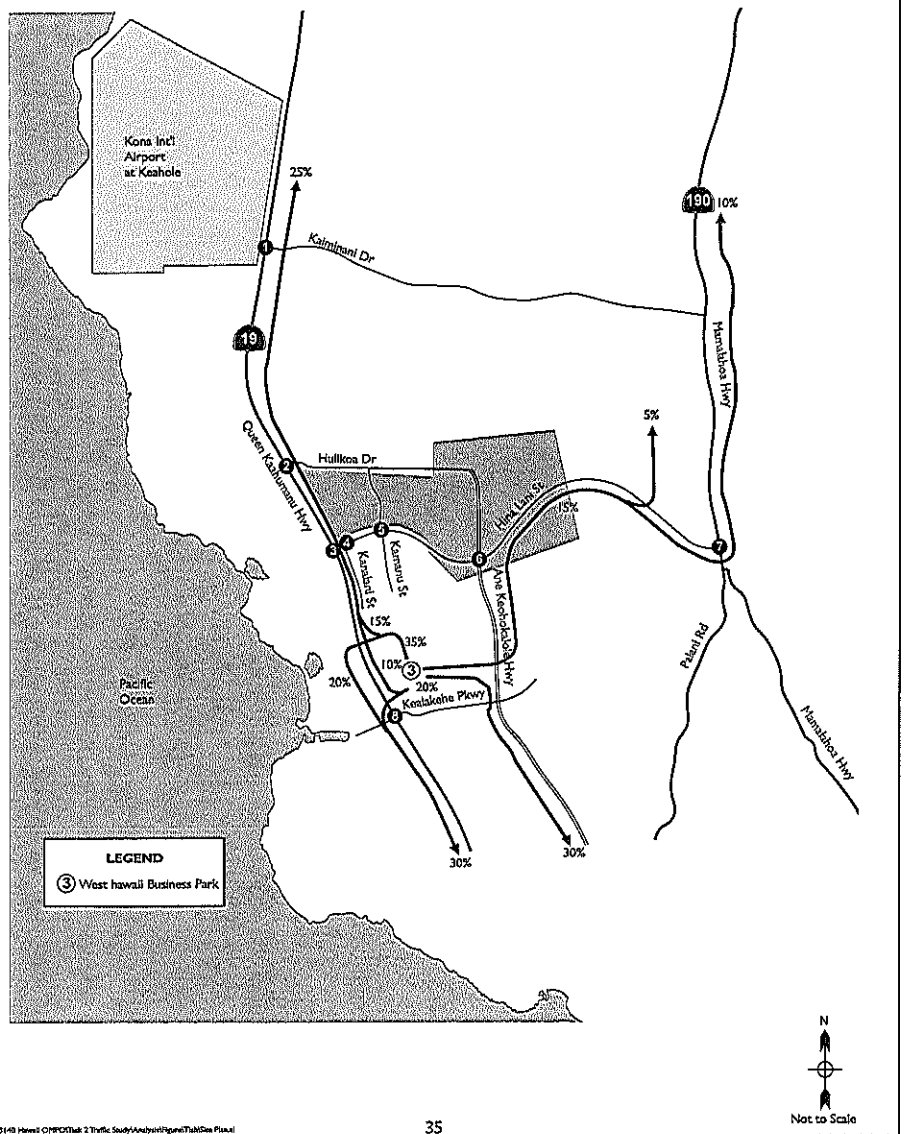
Kona, Hawaii — Figure 17

Kaloko Makai Project — Other Cumulative Development Trip Distribution-Kula Nui



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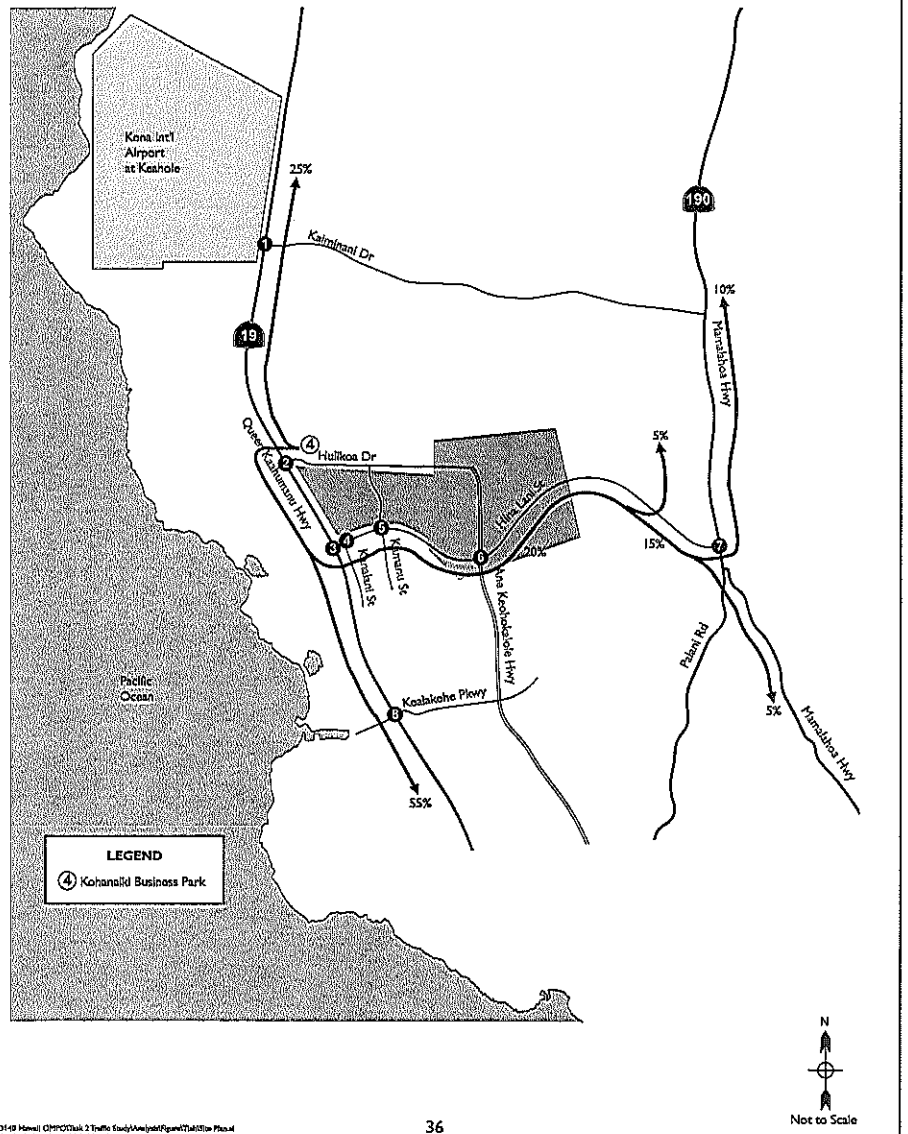
Kona, Hawaii — Figure 18

Kaloko Makai Project — Other Cumulative Development Trip Distribution-West Hawaii Business Park



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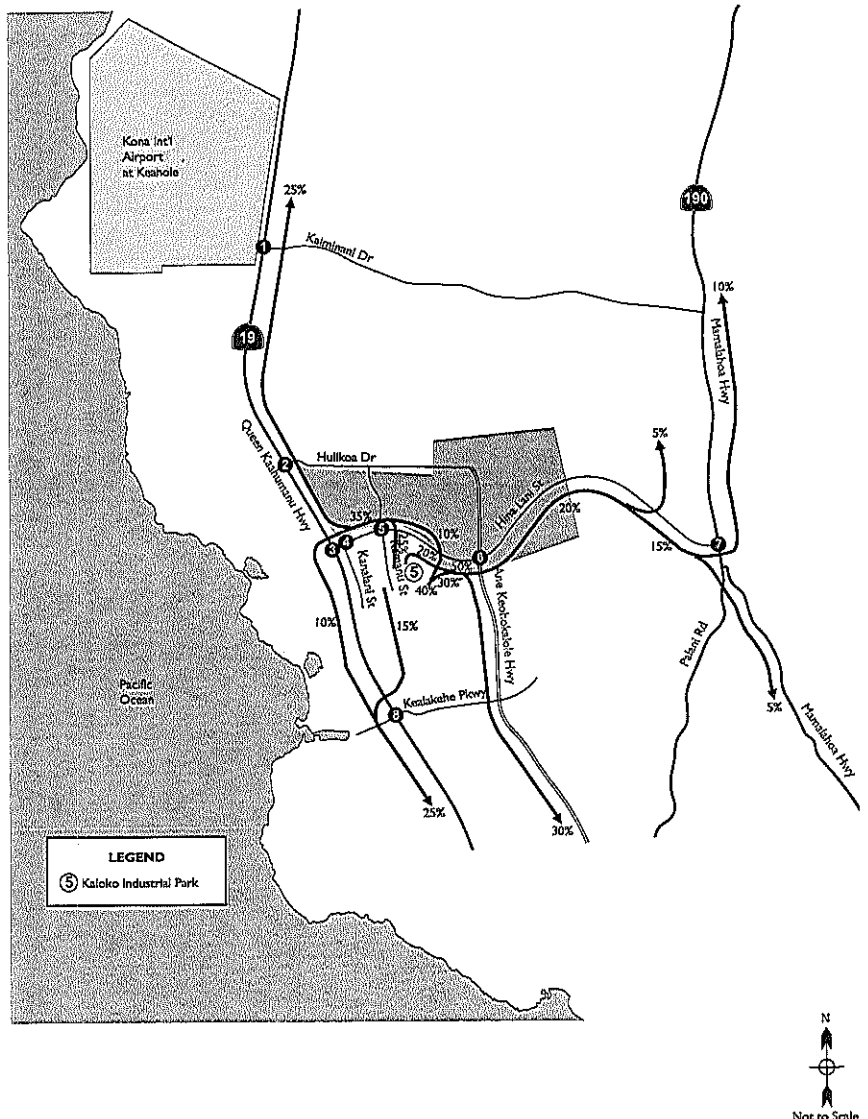
Kona, Hawaii — Figure 19

Kaloko Makai Project — Other Cumulative Development Trip Distribution-Kohanaiki Business Park



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KOA CORPORATION PLANNING & ENGINEERING | Kona, Hawaii | Figure 20
Kaloko Makai Project | Other Cumulative Development Trip Distribution-Kaloko Industrial Park

- Phase 1 (2015) – 15%
- Phase 2 (2025) – 51%
- Phase 3 (2035) – 99%

The 2.8% ambient growth rate is applied to the north-south directional through traffic along major highways to account for regional growth in the study area, including Queen Ka'ahumanu Highway (State Route 19) and Mamalahoa Highway (State Route 190). Appendix D shows the ambient background growth calculations.

3.10 Future Traffic Volumes

Based on the traffic forecast methodologies mentioned above, the future traffic volumes for the study area intersections and analysis years assessed in this traffic study are shown on the following tables:

- Table 8: 2015 Without Project Traffic
- Table 9: 2015 With Project Phase 1 Traffic
- Table 10: 2025 With Project Phase 2 Traffic
- Table 11: 2035 With Project Phase 3 Traffic

Table 8 - 2015 Without Project Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kaiminani Dr.	AM	0	778	102	33	733	0	0	0	0	480	0	244	2,370
		PM	0	1,022	380	226	1,012	0	0	0	0	180	0	84	2,904
2	Queen Kaahumanu Hwy./Hulikoa Dr.	AM	0	790	202	97	1,018	0	0	0	0	128	0	119	2,354
		PM	0	1,227	104	70	1,267	0	0	0	0	172	0	102	2,942
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	670	416	250	977	0	0	0	0	271	0	261	2,845
		PM	0	1,033	590	283	1,063	0	0	0	0	527	0	373	3,869
4	Kanalani St./ Hina Lani St.	AM	225	0	18	0	0	0	0	271	363	29	327	0	1,233
		PM	200	0	74	0	0	0	0	334	489	17	612	0	1,726
5	Kamanu St./ Hina Lani St.	AM	126	0	70	0	0	0	0	120	156	169	240	0	881
		PM	438	0	293	0	0	0	0	249	111	118	167	0	1,376
6	Ane Keohuokalole Hwy./Hina Lani St.	AM	80	4	64	0	6	0	0	164	16	189	403	0	926
		PM	21	3	282	0	4	0	0	535	78	180	260	0	1,363
7	Mamalahoa Hwy./ Hina Lani St.	AM	142	338	0	0	1,167	254	113	0	102	0	0	0	2,116
		PM	102	666	0	0	495	208	372	0	238	0	0	0	2,081
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	68	964	416	240	820	48	17	7	24	265	18	166	3,053
		PM	60	1,199	257	143	1,457	44	59	19	71	387	20	192	3,908

Table 9 - 2015 With Project Phase I Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kaiminani Dr.	AM	0	1,077	102	33	1,212	0	0	0	0	480	0	244	3,148
		PM	0	1,454	380	226	1,362	0	0	0	0	180	0	84	3,686
2	Queen Kaahumanu Hwy./Hulikoa Dr.	AM	0	974	245	281	1,312	0	0	0	0	162	0	234	3,208
		PM	0	1,493	140	205	1,483	0	0	0	0	217	0	268	3,806
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	713	1,035	544	1,011	0	0	0	0	651	0	445	4,399
		PM	0	1,070	1,038	499	1,108	0	0	0	0	1,081	0	639	5,435
4	Kanalani St./ Hina Lani St.	AM	225	0	18	0	0	0	0	1,184	363	29	891	0	2,710
		PM	200	0	74	0	0	0	0	998	489	17	1,431	0	3,209
5	Kamanu St./ Hina Lani St.	AM	126	0	70	87	0	249	346	687	156	169	555	126	2,571
		PM	438	0	293	130	0	358	268	644	111	118	629	94	3,083
6	Ane Keohuokalole Hwy./Hina Lani St.	AM	148	248	64	173	147	168	352	232	71	189	490	300	2,582
		PM	79	174	282	259	215	275	223	625	150	180	332	210	3,004
7	Mamalahoa Hwy./ Hina Lani St.	AM	344	338	0	0	1,167	437	228	0	228	0	0	0	2,742
		PM	250	666	0	0	495	343	539	0	420	0	0	0	2,713
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	68	1,626	563	240	1,234	48	17	7	24	357	18	166	4,368
		PM	60	1,684	365	143	2,055	44	59	19	71	520	20	192	5,232

Table 10 - 2025 With Project Phase 2 Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kaiminani Dr.	AM	0	1,533	102	33	1,674	0	0	0	0	480	0	244	4,066
		PM	0	2,003	380	226	1,870	0	0	0	0	180	0	84	4,743
2	Queen Kaahumanu Hwy./Hulikoa Dr.	AM	0	1,341	287	366	1,690	0	0	0	0	206	0	323	4,213
		PM	0	1,940	189	302	1,892	0	0	0	0	268	0	370	4,961
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	958	1,340	787	1,191	0	0	0	0	935	0	609	5,820
		PM	0	1,296	1,352	683	1,383	0	0	0	0	1,439	0	908	7,061
4	Kanalani St./ Hina Lani St.	AM	225	0	18	0	0	0	0	1,732	363	29	1,339	0	3,706
		PM	200	0	74	0	0	0	0	1,496	489	17	2,059	0	4,335
5	Kamanu St./ Hina Lani St.	AM	148	0	88	87	0	337	430	1,043	264	255	892	126	3,670
		PM	544	0	378	130	0	460	366	1,017	140	141	1,048	94	4,318
6	Ane Keohuokalole Hwy./Hina Lani St.	AM	278	318	148	217	222	319	496	418	97	278	753	342	3,886
		PM	113	251	380	310	297	449	389	905	277	282	559	259	4,471
7	Mamalahoa Hwy./ Hina Lani St.	AM	459	437	0	0	1,512	565	326	0	330	0	0	0	3,629
		PM	363	850	0	0	635	452	683	0	554	0	0	0	3,537
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	68	2,176	695	240	1,697	48	17	7	24	441	18	166	5,597
		PM	60	2,225	460	143	2,689	44	59	19	71	665	20	192	6,647

Table 11 - 2035 With Project Phase 3 Conditions Peak Hour Intersection Volumes

Int.	Intersection Name	Peak Hr.	Northbound			Southbound			Eastbound			Westbound			Total
			NL	NT	NR	SL	ST	SR	EL	ET	ER	WL	WT	WR	
1	Queen Kaahumanu Hwy./Kaiminani Dr.	AM	0	1,966	102	33	1,944	0	0	0	0	480	0	244	4,769
		PM	0	2,362	380	226	2,342	0	0	0	0	180	0	84	5,574
2	Queen Kaahumanu Hwy./Hulikoa Dr.	AM	0	1,750	289	378	1,948	0	0	0	0	212	0	347	4,924
		PM	0	2,284	196	326	2,341	0	0	0	0	271	0	385	5,803
3	Queen Kaahumanu Hwy./Hina Lani St.	AM	0	1,229	1,464	866	1,376	0	0	0	0	1,156	0	750	6,841
		PM	0	1,542	1,585	833	1,686	0	0	0	0	1,601	0	1,013	8,260
4	Kanalani St./ Hina Lani St.	AM	225	0	18	0	0	0	0	1,935	363	29	1,700	0	4,270
		PM	200	0	74	0	0	0	0	1,880	489	17	2,325	0	4,985
5	Kamanu St./ Hina Lani St.	AM	148	0	88	87	0	337	430	1,246	264	255	1,253	126	4,234
		PM	544	0	378	130	0	460	366	1,400	140	141	1,315	94	4,968
6	Ane Keohuokalole Hwy./Hina Lani St.	AM	296	335	186	217	251	339	502	580	124	348	1,020	342	4,540
		PM	147	273	449	310	317	461	411	1,178	306	325	751	259	5,187
7	Mamalahoa Hwy./ Hina Lani St.	AM	497	568	0	0	1,970	600	389	0	400	0	0	0	4,424
		PM	437	1,095	0	0	823	519	729	0	604	0	0	0	4,207
8	Queen Kaahumanu Hwy./Kealakehe Pkwy.	AM	68	2,571	723	240	2,103	48	17	7	24	491	18	166	6,476
		PM	60	2,704	514	143	3,154	44	59	19	71	702	20	192	7,682

4. Existing Conditions

This section documents existing conditions in the study area, including local land uses, roadway characteristics, and intersection operation performance. The discussion presented here is limited to specific roadways and study area intersections in the project vicinity.

4.1 Existing Land Use

The project site is currently vacant. The surround area is also mostly vacant. There is an industrial park located at the southeast corner at the intersection of Queen Ka'ahumanu Highway and Hina Lani Street.

4.2 Existing Roadway Network

Queen Ka'ahumanu Highway and Mamalahoa Highway currently provide regional access to the project site, and they both runs in a north-south direction. Hina Lani Street runs in an east-west direction through the project site, and Hina Lani Street connects to Queen Ka'ahumanu Highway to the west and Mamalahoa Highway to the east. Other local streets include Ka'iminani Drive, Hulikoa Drive, Kanalani Street, Kamanu Street, Kealakehe parkway, and Palani Road. Figure 21 shows the existing roadway and intersection lane configurations in the vicinity of the study roadway network.

Ane Keohokalole Highway is a future mid-level facility. A portion of the roadway from the south through the project site is anticipated to be constructed prior to Year 2015. The remaining section is not known when it will be completed. In the study area, Queen Ka'ahumanu Highway will also be widened to four lanes before Year 2015.

4.3 Traffic Count Data

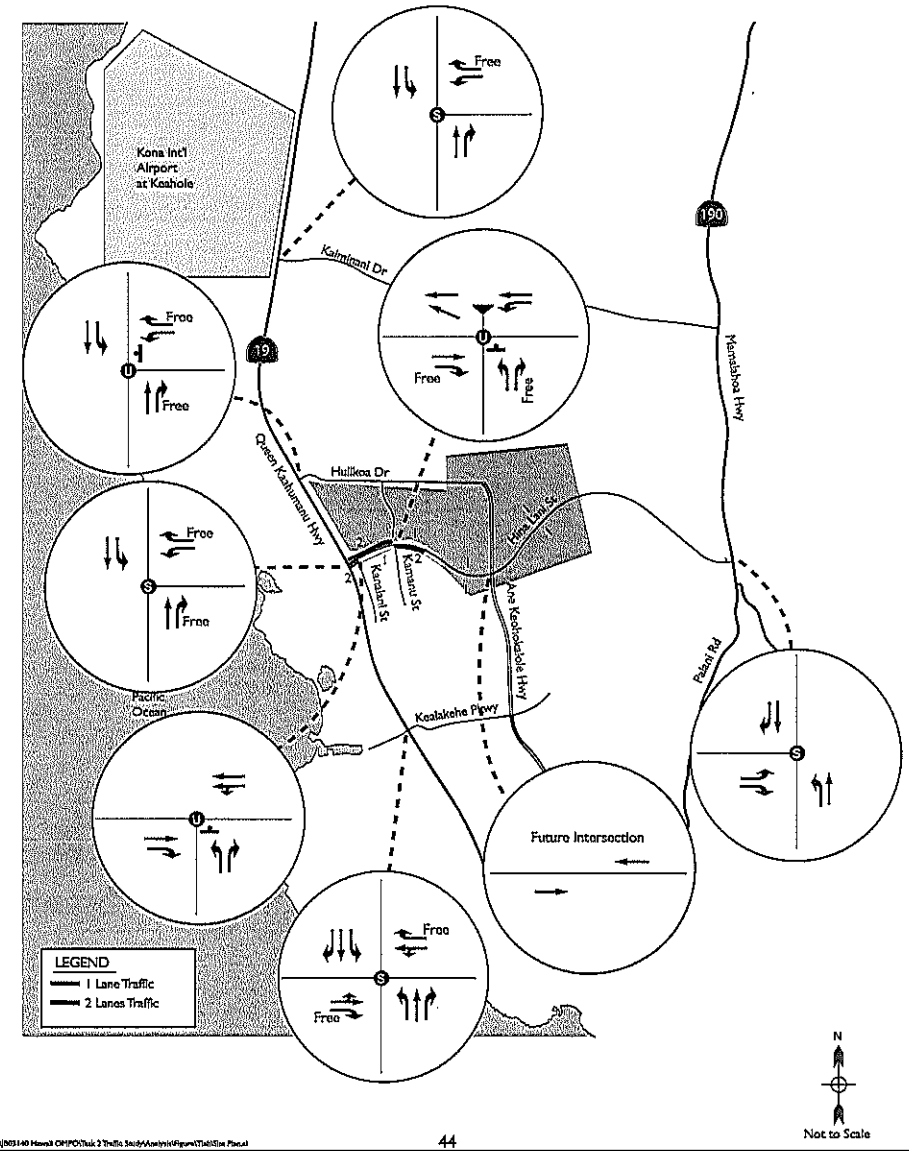
Figure 22 shows the existing peak hour traffic volumes at the study intersections. The AM and PM peak hour counts conducted on Tuesday, September 21, and Wednesday, September 22 in Year 2010. The AM and PM peak periods for the count data are from 6:00 AM to 9:00 AM and from 3:00 PM to 6:00 PM, respectively.

4.4 Existing Transit Service

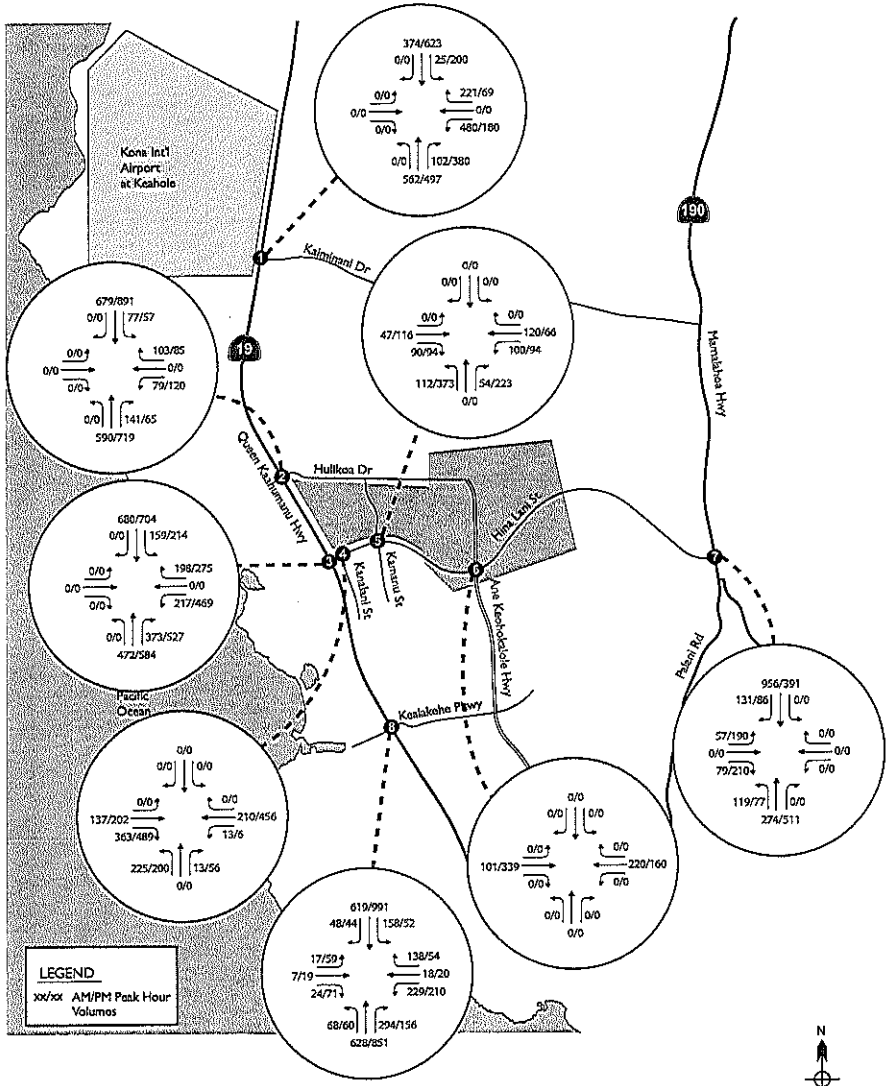
The County of Hawaii Mass Transit Agency provides an island-wide public bus transit system, called Hele-on Bus. The Hele-on Bus currently provides bus service along Queen Ka'ahumanu Highway (State Route 19) in the study area. The Hele-on Bus route map and schedule are included in Appendix E.

4.5 Level of Service Analysis of Existing Conditions

Intersection Level of Service (LOS) analysis was conducted using Synchro 6.0 software based on the analysis methodologies mentioned in Chapter 2 on this report. Table 12 below shows the existing intersection LOS for both AM and PM peak hours. Appendix F contains the Synchro level of service analysis worksheets for the Existing Conditions. As shown in the Table 12, the study area intersections currently operate at Level of Service D or better during AM and PM peak hours.



KOA CORPORATION PLANNING & ENGINEERING | Kona, Hawaii | Figure 21
Kaloko Makai Project | Existing Lane Geometry



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Kona, Hawaii — Figure 22

Kaloko Makai Project — Existing AM/PM Peak Hour Intersection Movement Volumes

Table 12 - Existing Conditions
Intersection Level of Service Analysis Summary

No.	Intersection	Peak Hour	EXISTING Delay (Sec)	V / C	LOS
1	Queen Ka'ahumanu Hwy at Kalaniana'ole Drive	AM	14.5	0.75	B
		PM	10.1	0.55	B
2	Queen Ka'ahumanu Hwy at Hulikoa Drive[1]	AM	16.5	0.50	C
		PM	22.9	0.60	C
3	Queen Ka'ahumanu Hwy at Hina Lani Street	AM	11.7	0.62	B
		PM	23.8	0.83	C
4	Kanalani Street at Hina Lani Street[1]	AM	13.3	0.36	B
		PM	15.8	0.50	C
5	Kamanu Street at Hina Lani Street[1]	AM	10.7	0.25	B
		PM	14.1	0.39	B
6	Ane Keahokalole Hwy at Hina Lani Street[2]	AM	--	--	--
		PM	--	--	--
7	Mamalahoa Hwy at Hina Lani Street	AM	11.3	0.71	B
		PM	6.6	0.39	A
8	Queen Ka'ahumanu Hwy at Kealakehe Pkwy	AM	17.0	0.76	B
		PM	27.4	0.91	C

[1] Non-signalized. The delay is for the most constrained stop-controlled approach.

[2] Intersection does not currently exist.

5. 2015 Traffic Conditions

This chapter documents the intersection operations analysis for 2015 Without Project Conditions and 2015 With Project Phase 1 Conditions for the study area.

5.1 Future Traffic Volumes for 2015 Without Project Conditions

Future intersection traffic volumes for 2015 Without Project Conditions are shown on Figure 23. The future traffic forecast is estimated based on the methodologies are presented in Chapter 3.

5.2 Level of Service Analysis for 2015 Without Project Conditions

Synchro 6.0 software was used to conduct intersection level of service analysis. Table 13 summarizes the results for the 2015 Without Project Condition intersection level of service analysis. Appendix G contains the Synchro level of service analysis worksheets for the 2015 Without Project Conditions. As shown on Table 13, the following study area intersections are projected to operate at unacceptable levels of service for 2015 Without Project Conditions during the peak hours, with existing lane geometry:

- Queen Ka'ahumanu Highway at Hulikoa Drive
- Queen Ka'ahumanu Highway at Hina Lani Street
- Ane Keahokalole Highway at Hina Lani Street
- Queen Ka'ahumanu Highway at Kealakehe Parkway

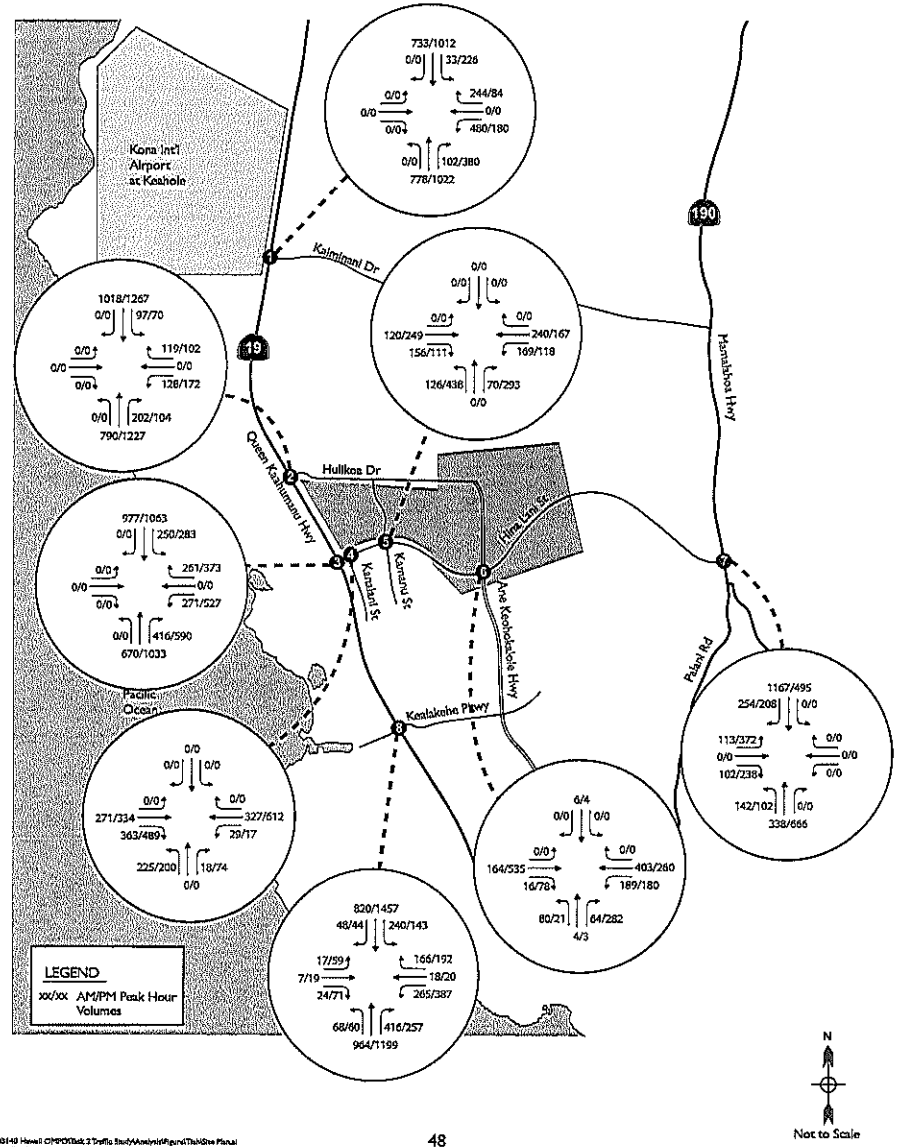
5.3 Future Traffic Volumes for 2015 With Project Phase 1 Conditions

Future intersection traffic volumes for 2015 With Project Phase 1 Conditions are shown on Figure 24. The future traffic forecast is estimated based on the methodologies are presented in Chapter 3. It should be noted that in addition to the project-only traffic, the 2015 With Project Phase 1 Conditions also includes cumulative development traffic in the vicinity of the project site as well as ambient background growth to account for other unidentified projects and general population growth

5.4 Level of Service Analysis for 2015 With Project Phase 1 Conditions

Synchro 6.0 software was used to conduct intersection level of service analysis. Table 13 summarizes the results for the 2015 With Project Phase 1 Condition intersection level of service analysis. Appendix H contains the Synchro level of service analysis worksheets for the 2015 With Project Phase 1 Conditions, with existing lane geometry. As shown on Table 13, the following study area intersections are projected to operate at unacceptable levels of service for 2015 With Project Phase 1 Conditions during the peak hours, with existing lane geometry:

- Queen Ka'ahumanu Highway at Ka'iminani Drive
- Queen Ka'ahumanu Highway at Hulikoa Drive



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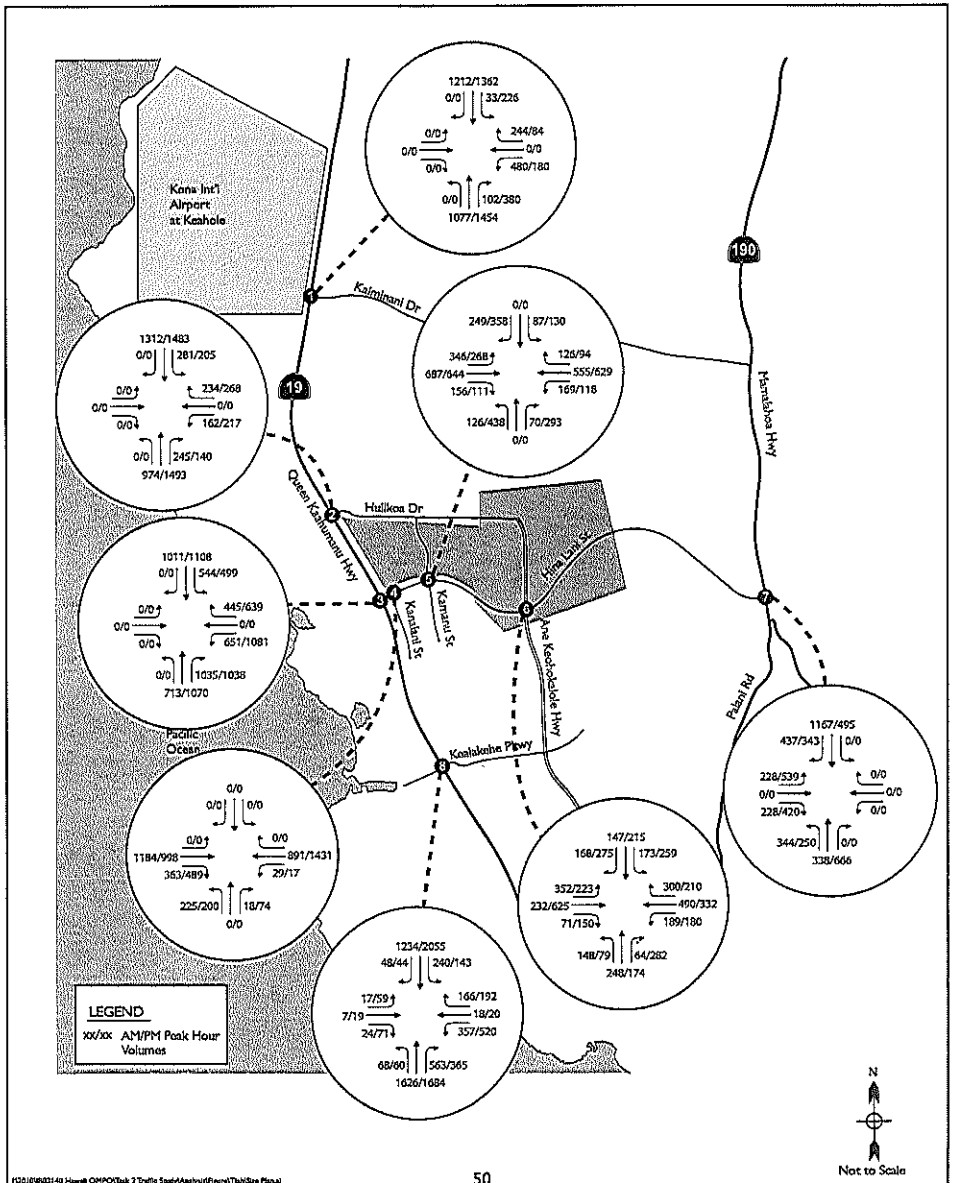
KOA CORPORATION PLANNING & ENGINEERING | Kona, Hawaii | Figure 23
Kaloko Makai Project | 2015 Without Project AM/PM Peak Hour Intersection Movement Volumes

Table 13 - 2015 Without and With Project Phase 1 Conditions
Intersection Level of Service Analysis Summary

No.	Intersection	Peak Hour	WITHOUT PROJECT				WITH PROJECT					WITH PROJECT PLUS MITIGATION				
			Delay (Sec)	V/C	LOS	Cum. Impact	Delay (Sec)	V / C	LOS	Delay Change	Project Impact	Delay (Sec)	V/C	LOS	Delay Change	Project Impact
1	Queen Ka'ahumanu Hwy at Kaiminani Drive	AM	21.8	0.85	C	NO	58.2	1.07	E	36.4	YES	17.8	0.77	B	-4.0	NO
		PM	27.9	0.93	C	NO	71.3	1.16	E	43.4	YES	14.4	0.78	B	-13.5	NO
2	Queen Ka'ahumanu Hwy at Hulikoa Drive	AM	35.0	0.67	E	YES	>100	0.86	F	--	YES	10.6	0.64	B	-24.4	NO
		PM	>100	0.83	F	YES	>100	1.12	F	--	YES	13.3	0.77	B	--	NO
3	Queen Ka'ahumanu Hwy at Hina Lani Street	AM	20.0	0.83	C	NO	>100	1.27	F	--	YES	13.1	0.72	B	-6.9	NO
		PM	79.5	1.19	E	YES	>100	1.74	F	--	YES	27.7	0.98	C	-51.8	NO
4	Kanalani Street at Hina Lani Street	AM	20.8	0.47	C	NO	31.7	0.72	D	10.9	NO	15.5	0.43	C	-5.3	NO
		PM	26.3	0.55	D	NO	32.4	0.83	D	6.1	NO	14.5	0.48	B	-11.8	NO
5	Kamanu Street at Hina Lani Street	AM	14.9	0.30	B	NO	>100	1.28	F	--	YES	26.0	0.70	C	11.1	NO
		PM	32.1	0.56	D	NO	>100	1.39	F	--	YES	29.9	0.80	C	-2.2	NO
6	Ane Keahokalole Hwy at Hina Lani Street	AM	61.6	0.46	F	YES	>100	0.83	F	--	YES	49.8	0.94	D	-11.8	NO
		PM	>100	0.57	F	YES	>100	0.80	F	--	YES	31.9	0.78	C	--	NO
7	Mamalahoa Hwy at Hina Lani Street	AM	28.2	0.91	C	NO	71.7	1.08	E	43.5	YES	20.6	0.81	C	-7.6	NO
		PM	15.8	0.71	B	NO	26.2	0.84	C	10.4	NO	26.2	0.84	C	10.4	NO
8	Queen Ka'ahumanu Hwy at Kealakehe Pkwy	AM	43.7	1.03	D	NO	>100	1.48	F	--	YES	29.4	0.88	C	-14.3	NO
		PM	>100	1.38	F	YES	>100	1.80	F	--	YES	38.3	0.96	D	--	NO



- Queen Ka'ahumanu Highway at Hina Lani Street
- Kamanu Street at Hina Lani Street
- Ane Keahokalole Highway at Hina Lani Street
- Mamalahoa Highway at Hina Lani Street
- Queen Ka'ahumanu Highway at Kealakehe Parkway

With recommended 2015 intersection lane improvements, the study area intersections are projected to be mitigated to acceptable Level of Service "D" or better during the peak hours for 2015 With Project Phase 1 Conditions. The intersection operations analysis worksheets for 2015 With Project Phase 1 Conditions, with recommended mitigation measures, are included in Appendix I of this report. A summary of the recommended 2015 roadway improvements are presented in subsequent Chapter 8.

It should noted that Ane Keohokalole Highway will be a future mid-level facility with a portion of it to be constructed prior to Year 2015, and it will run in a north-south direction through the project site. In the study area, Queen Ka'ahumanu Highway will also be widened to four lanes before Year 2015.

6. 2025 Traffic Conditions

This chapter documents the intersection operations analysis for 2025 With Project Phase 2 Conditions for the study area.

6.1 Future Traffic Volumes for 2025 With Project Phase 2 Conditions

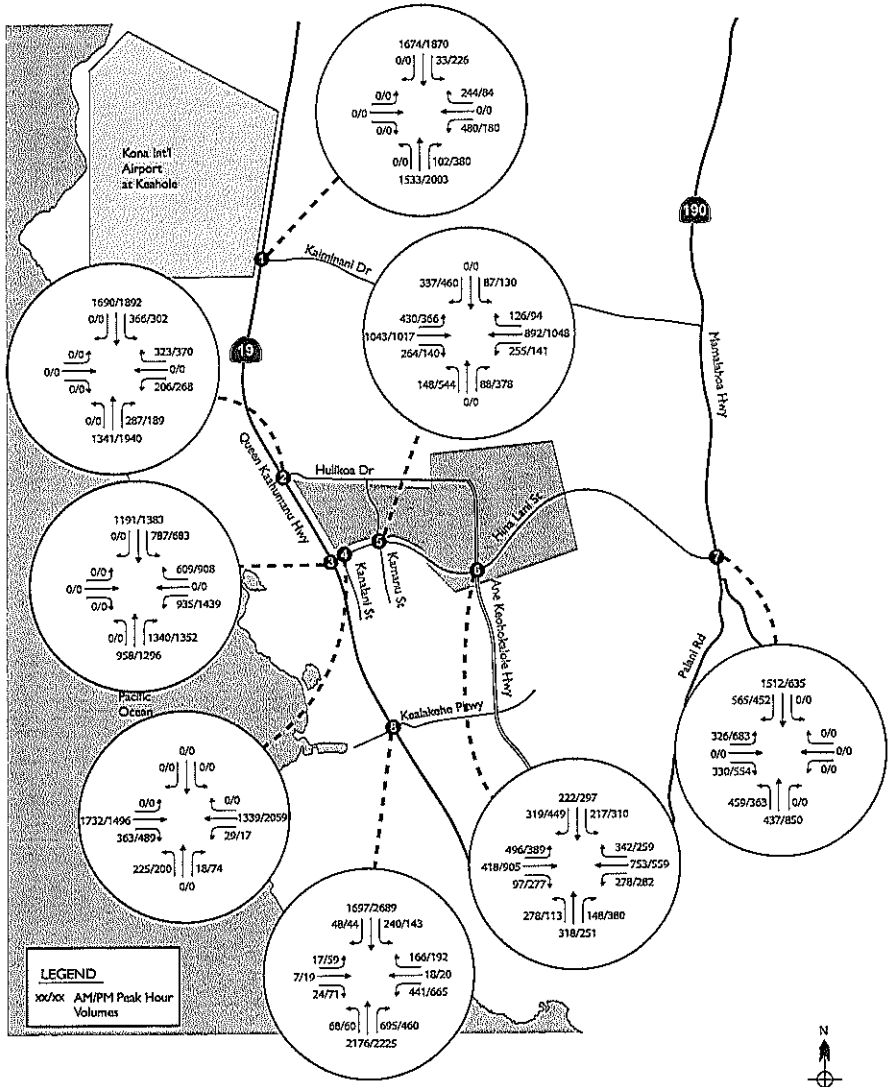
Future intersection traffic volumes for 2025 With Project Phase 2 Conditions are shown on Figure 25. The future traffic forecast is estimated based on the methodologies are presented in Chapter 3. It should be noted that in addition to the project-only traffic, the 2025 With Project Phase 2 Conditions also includes cumulative development traffic in the vicinity of the project site as well as ambient background growth to account for other unidentified projects and general population growth. The project is only one of the many contributors to the overall traffic growth.

6.2 Level of Service Analysis for 2025 With Project Phase 2 Conditions

Synchro 6.0 software was used to conduct intersection level of service analysis. Table 14 summarizes the results for the 2025 With Project Phase 2 Condition intersection level of service analysis. Appendix J contains the Synchro level of service analysis worksheets for the 2025 With Project Phase 2 Conditions, with existing lane geometry. As shown on Table 14, the following study area intersections are projected to operate at unacceptable levels of service for 2025 With Project Phase 2 Conditions during the peak hours, with existing lane geometry:

- Queen Ka'ahumanu Highway at Ka'iminani Drive
- Queen Ka'ahumanu Highway at Hulikoa Drive
- Queen Ka'ahumanu Highway at Hina Lani Street
- Kanalani Street at Hina Lani Street
- Kamanu Street at Hina Lani Street
- Ane Keahokalole Highway at Hina Lani Street
- Mamalahoa Highway at Hina Lani Street
- Queen Ka'ahumanu Highway at Kealakehe Parkway

With recommended 2025 intersection lane improvements, the study area intersections are projected to be mitigated to acceptable Level of Service "D" or better during the peak hours for 2025 With Project Phase 2 Conditions. The intersection operations analysis worksheets for 2025 With Project Phase 2 Conditions, with recommended mitigation measures, are included in Appendix K of this report. A summary of the recommended 2025 roadway improvements are presented in subsequent Chapter 8.



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Kona, Hawaii — Figure 25

Kaloko Makai Project — 2025 With Project Phase 2 AM/PM Peak Hour Intersection Movement Volumes

Table 14 - 2025 With Project Phase 2 Conditions
Intersection Level of Service Analysis Summary

No.	Intersection	Peak Hour	WITH PROJECT				WITH PROJECT PLUS MITIGATION			
			Delay (Sec)	V / C	LOS	Project Impact	Delay (Sec)	V / C	LOS	Project Impact
1	Queen Ka'ahumanu Hwy at Kaiminani Drive	AM	>100	1.34	F	YES	14.5	0.75	B	NO
		PM	>100	1.47	F	YES	19.2	0.88	B	NO
2	Queen Ka'ahumanu Hwy at Hulikoa Drive	AM	>100	1.12	F	YES	15.3	0.74	B	NO
		PM	>100	1.44	F	YES	26.1	0.93	C	NO
3	Queen Ka'ahumanu Hwy at Hina Lani Street	AM	>100	1.80	F	YES	Interchange			NO
		PM	>100	2.25	F	YES				NO
4	Kanalani Street at Hina Lani Street	AM	91.0	1.01	F	YES	24.2	0.44	C	NO
		PM	>100	1.00	F	YES	21.0	0.47	C	NO
5	Kamanu Street at Hina Lani Street	AM	>100	1.71	F	YES	30.6	0.72	C	NO
		PM	>100	1.92	F	YES	42.7	0.92	D	NO
6	Ane Keahokalole Hwy at Hina Lani Street	AM	>100	1.11	F	YES	34.6	0.83	C	NO
		PM	>100	1.07	F	YES	26.5	0.74	C	NO
7	Mamalahoa Hwy at Hina Lani Street	AM	>100	1.44	F	YES	40.9	0.95	D	NO
		PM	65.6	1.09	E	YES	19.9	0.82	B	NO
8	Queen Ka'ahumanu Hwy at Keaalaehe Pkwy	AM	>100	1.92	F	YES	28.1	0.88	C	NO
		PM	>100	2.40	F	YES	46.5	0.96	D	NO

7. 2035 Traffic Conditions

This chapter documents the intersection operations analysis for 2035 With Project Phase 3 Conditions for the study area.

7.1 Future Traffic Volumes for 2035 With-Project Phase 3 Conditions

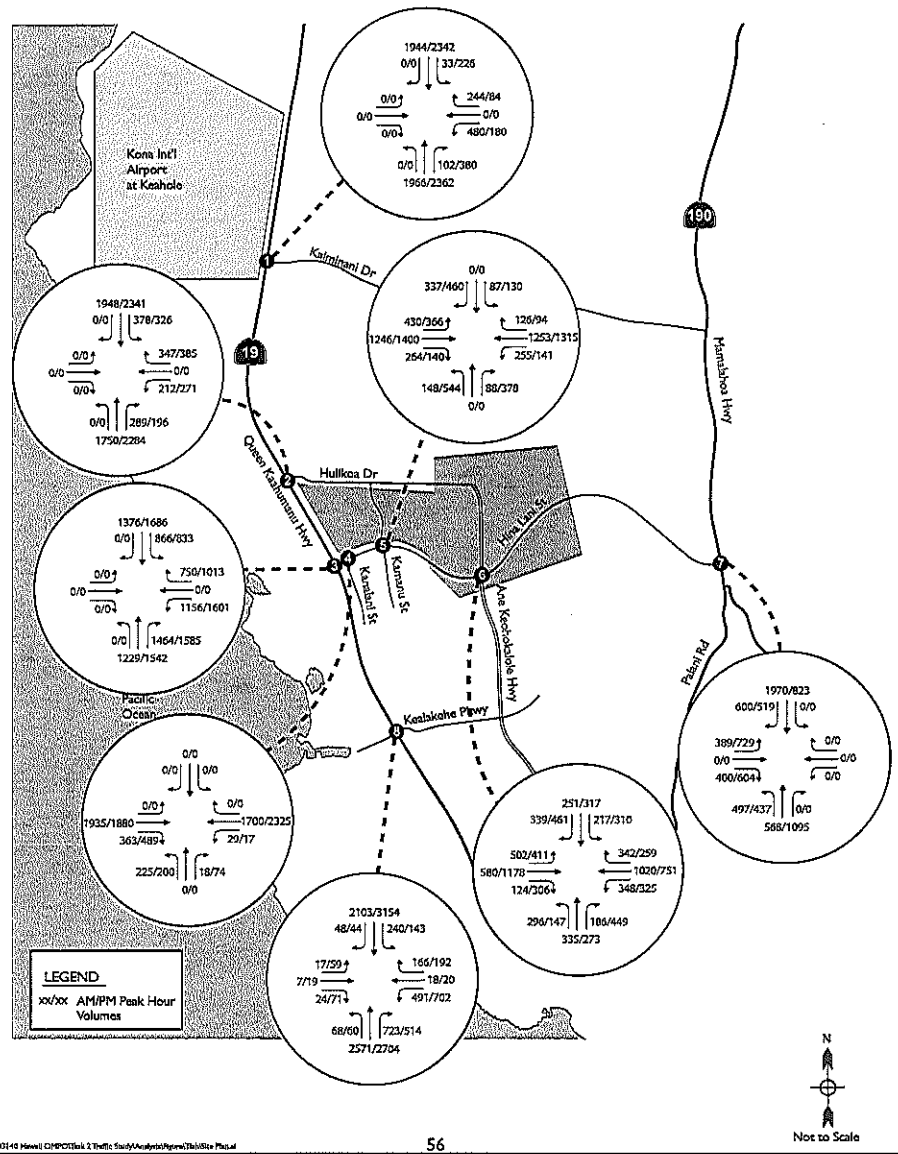
Future intersection traffic volumes for 2035 With Project Phase 3 Conditions are shown on Figure 26. The future traffic forecast is estimated based on the methodologies are presented in Chapter 3. It should be noted that in addition to the project-only traffic, the 2035 With Project Phase 3 Conditions also includes cumulative development traffic in the vicinity of the project site as well as ambient background growth to account for other unidentified projects and general population growth. The project is only one of the many contributors to the overall traffic growth.

7.2 Level of Service Analysis for 2035 With Project Phase 3 Conditions

Synchro 6.0 software was used to conduct intersection level of service analysis. Table 15 summarizes the results for the 2035 With Project Phase 3 Condition intersection level of service analysis. Appendix L contains the Synchro level of service analysis worksheets for the 2035 With Project Phase 3 Conditions, with existing lane geometry. As shown on Table 15, the following study area intersections are projected to operate at unacceptable levels of service for 2035 With Project Phase 3 Conditions during the peak hours, with existing lane geometry:

- Queen Ka'ahumanu Highway at Ka'iminani Drive
- Queen Ka'ahumanu Highway at Hulikoa Drive
- Queen Ka'ahumanu Highway at Hina Lani Street
- Kanalani Street at Hina Lani Street
- Kamanu Street at Hina Lani Street
- Ane Keahokalole Highway at Hina Lani Street
- Mamalahoa Highway at Hina Lani Street
- Queen Ka'ahumanu Highway at Kealakehe Parkway

With recommended 2035 intersection lane improvements, the study area intersections are projected to be mitigated to acceptable Level of Service "D" or better during the peak hours for 2035 With Project Phase 3 Conditions. The intersection operations analysis worksheets for 2035 With Project Phase 3 Conditions, with recommended mitigation measures, are included in Appendix M of this report. A summary of the recommended 2035 roadway improvements are presented in subsequent Chapter 8.



KOA CORPORATION PLANNING & ENGINEERING | Kona, Hawaii | Figure 26
Kaloko Makai Project 2035 With Project Phase 3 AM/PM Peak Hour Intersection Movement Volumes

Table 15 - 2035 With Project Phase 3 Conditions
Intersection Level of Service Analysis Summary

No.	Intersection	Peak Hour	WITH PROJECT				WITH PROJECT PLUS MITIGATION			
			Delay (Sec)	V / C	LOS	Project Impact	Delay (Sec)	V / C	LOS	Project Impact
1	Queen Ka'ahumanu Hwy at Kaiminani Drive	AM	>100	1.52	F	YES	19.7	0.91	B	NO
		PM	>100	1.73	F	YES	29.6	0.97	C	NO
2	Queen Ka'ahumanu Hwy at Hulikoa Drive	AM	>100	1.35	F	YES	20.4	0.85	C	NO
		PM	>100	1.63	F	YES	40.3	1.01	D	NO
3	Queen Ka'ahumanu Hwy at Hina Lani Street	AM	>100	2.16	F	YES	Interchange			NO
		PM	>100	2.62	F	YES				NO
4	Kanalani Street at Hina Lani Street	AM	>100	1.12	F	YES	29.3	0.47	D	NO
		PM	>100	1.10	F	YES	29.3	0.52	D	NO
5	Kamanu Street at Hina Lani Street	AM	>100	2.01	F	YES	27.8	0.70	C	NO
		PM	>100	2.27	F	YES	35.4	0.82	D	NO
6	Ane Keahokalole Hwy at Hina Lani Street	AM	>100	1.27	F	YES	46.8	0.94	D	NO
		PM	>100	1.25	F	YES	39.2	0.89	D	NO
7	Mamalahoa Hwy at Hina Lani Street	AM	>100	1.72	F	YES	41.4	0.98	D	NO
		PM	>100	1.30	F	YES	28.5	0.98	C	NO
8	Queen Ka'ahumanu Hwy at Kealakehe Pkwy	AM	>100	2.19	F	YES	40.8	1.19	D	NO
		PM	>100	2.67	F	YES	53.8	1.17	D	NO

8. RECOMMENDED IMPROVEMENTS

Under future with project scenarios, the study area intersections are expected to deficient levels of service. Improvement measures have been evaluated for all future with project scenarios. The purposes of the recommended improvements are to improve traffic operation for the study area intersections. It should be noted that the recommended improvements for each horizon are needed to serve overall traffic growth which includes the project-only traffic and cumulative development traffic as well as ambient background growth to account for other unidentified projects and general population growth. The project is only one of the many contributors to the overall traffic growth.

It is recommended that the traffic study be updated periodically every 5 years to monitor the actual traffic growth and provide appropriate mitigation.

8.1 Year 2015 Improvements

Recommended improvement measures and intersection operation performance improvements are reported in this section. Figure 27 shows the recommended roadway network and intersection lane geometry for the 2015 With Project Phase 1 Conditions to mitigate the forecast impact within the study area. For the intersection Kanalani Street at Hina Lani Street, it is recommended that the northbound left turn movement be restricted and the intersection remains stop-controlled for the northbound approach. Traffic signals are recommended to be installed at the following three study area intersections:

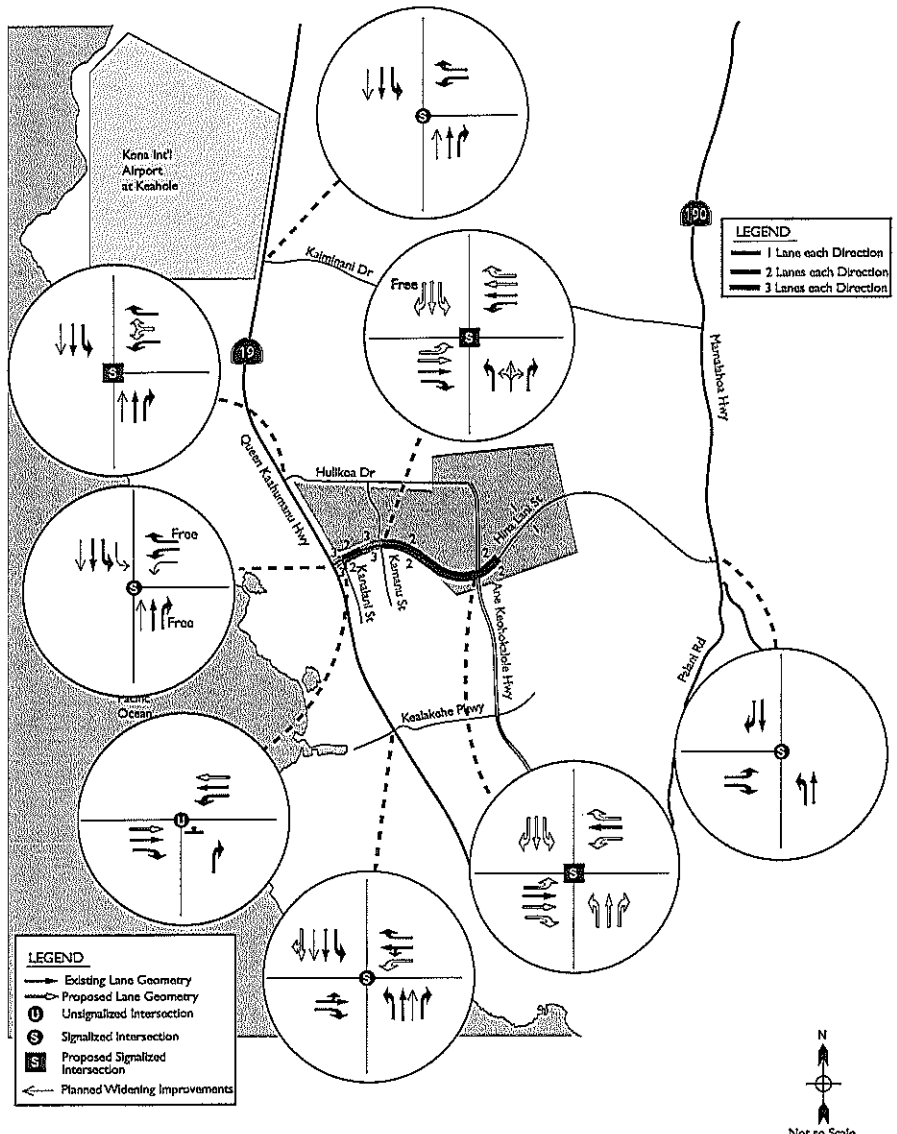
- Queen Ka'ahumanu Highway at Hulikoa Drive
- Kamanu Street at Hina Lani Street
- Ane Keahokalole Highway at Hina Lani Street

It should be noted that the following roadway improvements are planned for completion prior to Year 2015, without the proposed Kaloko Makai Village project:

- Ane Keohokalole Highway will be a future mid-level facility, and it will run in a north-south direction through the project site.
- Queen Ka'ahumanu Highway will be widened to four lanes in the study area.

8.2 Year 2025 Improvements

Recommended improvement measures and intersection operation performance improvements are reported in this section. Figure 28 shows the recommended roadway network and intersection lane geometry for the 2025 With Project Phase 2 Conditions to mitigate the forecast impact within the study area. A grade-separated interchange is recommended for the intersection of Queen Ka'ahumanu Highway at Hina Lani Street to mitigate traffic impact.



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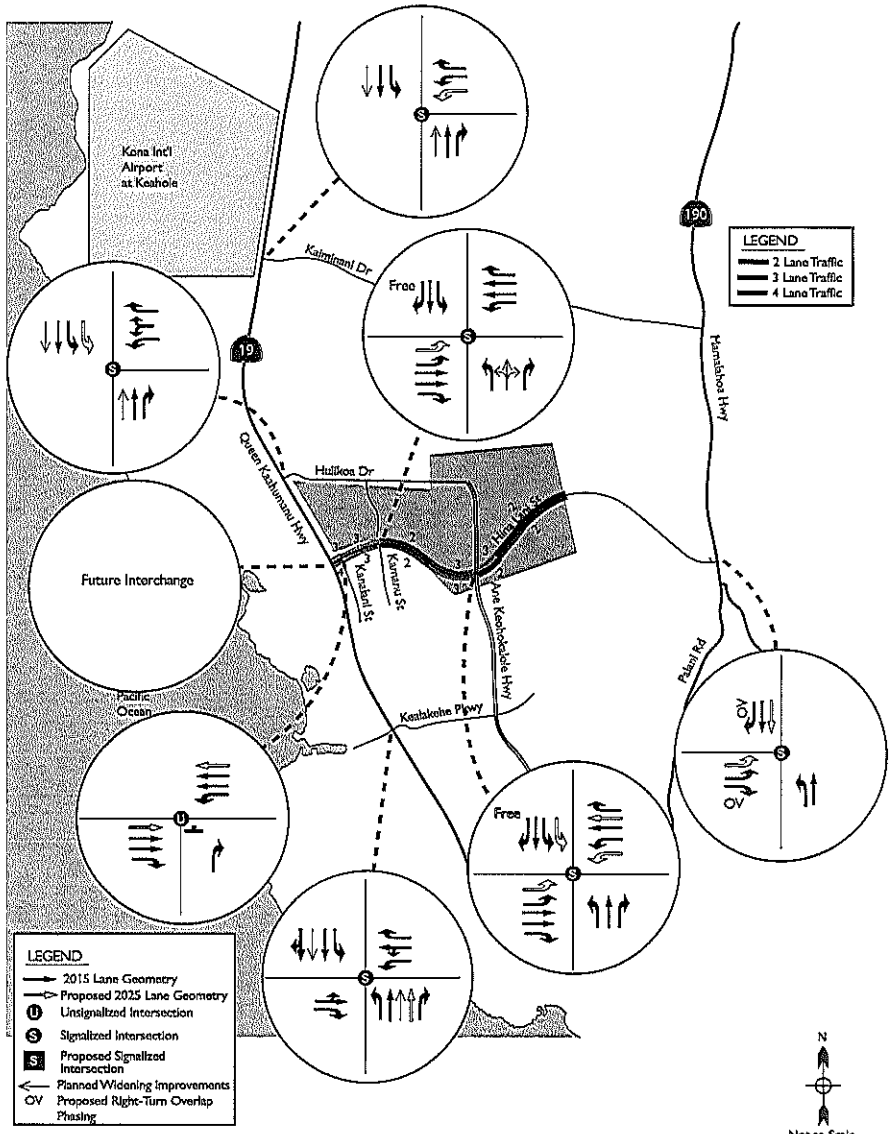
Kona, Hawaii — Figure 27

Kaloko Makai Project — Recommended 2015 Lane Geometry



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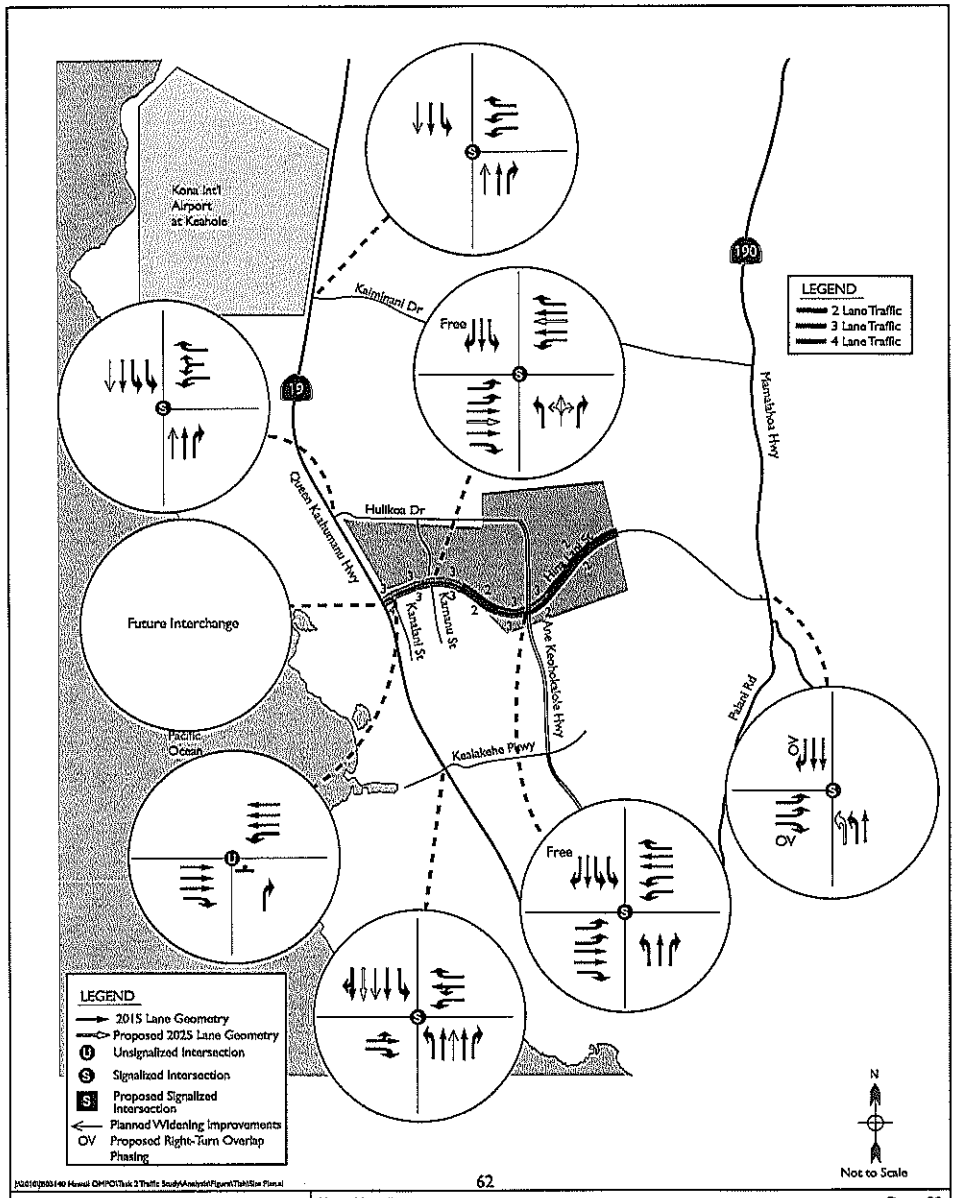
Kona, Hawaii — Figure 28

Kaloko Makai Project — Recommended 2025 Lane Geometry

8.3 Year 2035 Improvements

Recommended improvement measures and intersection operation performance improvements are reported in this section. Figure 29 shows the recommended roadway network and intersection lane geometry for the 2035 With Project Phase 3 Conditions to mitigate the forecast impact within the study area.



KOA CORPORATION PLANNING & ENGINEERING | Kona, Hawaii | Figure 29
Kaloko Makai Project | Recommended 2035 Lane Geometry

Conclusions

The purpose of this study is to assess the overall cumulative traffic impact and the proposed Kaloko Makai Village project, which will be developed in 3 phases, for 2015, 2025 and 2035 conditions.

This study used the existing traffic volumes and the surrounding land use and geographic conditions to determine the project trip distribution patterns. ITE trip rates are used to estimate the site-only project traffic volumes, and trip reduction adjustment has been made to the overall project traffic generation to account for pass-by trips, internal capture and transit trip discount. The reduction percentage assumption has been based on past experience for this type of development and the reference information obtained from other studies in the area.

Future traffic increases also consider additional traffic that are generated by other cumulative developments that either is under construction, approved, planned, or proposed for development near the study area based on available information obtained by the project team. In addition to cumulative development traffic, other unidentified projects and general population growth contribute to ambient background traffic growth. Ambient growth is calculated as an annual growth percentage increase from existing traffic count volumes, based on a comparison of the 2007 and 2010 traffic count data for the intersection of Queen Ka'ahumanu Highway at Hina Lani Street.

Synchro 6 models were developed to conduct intersection level of service analyses. Analysis methodologies and parameters are presented in Chapter 2 of this report.

The document presents the recommended mitigation improvements to the study area intersections. Figures 27, 28, and 29 summarize the recommended roadway network and intersection lane geometry for 2015, 2025 and 2035 conditions with project, respectively. The following improvements should be considered to mitigate the forecast impacts generated by the overall traffic growth and the proposed Kaloko Makai Village project:

- For the intersection Kanalani Street at Hina Lani Street, it is recommended that the northbound left turn movement be restricted and the intersection remains stop-controlled for the northbound approach.

- Traffic signals are recommended to be installed at the following three unsignalized or new study area intersections:

    - Queen Ka'ahumanu Highway at Hulikoa Drive
    - Kamanu Street at Hina Lani Street
    - Ane Keahokalole Highway at Hina Lani Street

- In 2025, a grade-separated interchange is recommended for the intersection of Queen Ka'ahumanu Highway at Hina Lani Street to mitigate traffic impact.

With the recommended improvements to the surrounding roadway network, the forecast traffic impact will be mitigated to an acceptable level.

It should be noted that the following roadway improvements are planned for completion prior to Year 2015, without the proposed Kaloko Makai Village project:

- Ane Keohokalole Highway will be a future mid-level facility, and it will run in a north-south direction through the project site.
- Queen Ka'ahumanu Highway will be widened to four lanes in the study area.

It is recommended that the traffic study be updated periodically every 5 years to monitor the actual traffic growth and provide appropriate mitigation.

KALOKO MAKAI - BUSINESS PLAN

REAL ESTATE SCHEDULE
GENERAL ASSUMPTIONS MADE

Printed: 05/09/11

USE CODES:

1 SFD
2 MF
3 COMMERCIAL
4 BUILT AMENITIES
5 PARK - OPEN SPACE
6 SCHOOL
7 CIRCULATION
8 INDUSTRIAL
9 CIVIC USE

USE	KONA VDG CODE	PARCEL I.D.	ZONING *	TYPE (See "Use Codes")	PARCEL SIZE (Ac)	MAX DENSITY ALLOWED	DENSITY BEING USED	# OF UNITS	COMMERCIAL: RETAIL	COMMERCIAL: OFFICE	COMMERCIAL: LIGHT INDUS.	OTHER: HOSPITAL BEDS	OTHER: ELEMENTARY (Enrollment)	OTHER: MIDDLE (Enrollment)	OTHER: PARK/OPEN SPACE
		PHASE 1													
WWTP	WWTP	WWTP		9	20.00										
Light Industrial	SD1	SD1		2,3,8	75.00						75.00 gr. ac.				
District-scale Park	PARK	P-4		5	25.00										
MF Affordable	T5	T5-13		2,3	19.70	30.0 du/ac	17.0 du/ac	335 /du							
Live-Work	T4	T4-11		2	10.00	12.0 du/ac	8.0 du/ac	80 /du	10,000 /sf	10,000 /sf					
Live-Work	T4	T4-12		2	16.30	12.0 du/ac	8.0 du/ac	130 /du	20,000 /sf	20,000 /sf					
Single-Family	T3	T3-17		1	11.30	6.0 du/ac	5.0 du/ac	57 /du							
Single-Family	T3	T3-16		1	9.00	6.0 du/ac	4.0 du/ac	36 /du							
Single-Family	T3	T3-15		1	14.70	6.0 du/ac	5.0 du/ac	74 /du							
Single-Family	T3	T3-14		1	10.80	6.0 du/ac	5.0 du/ac	54 /du							
Single-Family	T4	T3-13		1	10.30	12.0 du/ac	8.0 du/ac	82 /du	10,000 /sf	10,000 /sf					
TOD Park	PARK	P-3		5	9.50										
Elementary School		Elem School		9	12.00								450		
MF Market Senior (6.9-ac) Live-Work (6-ac)	T4	T4-7		2	12.90	12.0 du/ac	8.0 du/ac	103 /du	10,000 /sf	15,000 /sf					
MF Market Senior (2.5-ac) Live-Work (3-ac)	T4	T4-8		2	5.50	12.0 du/ac	8.0 du/ac	44 /du	10,000 /sf	15,000 /sf					
Live-Work	T4	T4-9		2	19.00	12.0 du/ac	8.0 du/ac	152 /du	25,000 /sf	25,000 /sf					
Transit Station TOD Square Mixed-Use	T5	T5-10		2,3	6.50	30.0 du/ac	15.0 du/ac	98 /du	25,000 /sf	25,000 /sf					
Shopping Center (25-ac) Urgent Care/Clinic Multi-Family (7.9-ac)	T5	T5-11		2,3	32.90	30.0 du/ac	7.0 du/ac	230 /du	175,000 /sf	25,000 /sf					
Mixed-Use	T5	T5-6		2,3	7.20	30.0 du/ac	15.0 du/ac	108 /du	25,000 /sf	25,000 /sf					
Judiciary	JUDICIARY	Judiciary		9	10.00										
Legal Office (11-ac) Retail (4-ac) Multi-Family (6.5-ac)	T5	T5-5		2,3	21.50	30.0 du/ac	11.0 du/ac	237 /du	50,000 /sf	100,000 /sf					
TOD Greenbelt	GREENBELT	Greenbelt		5	22.00										
		SUBTOTAL PHASE 1			381.10			1,819	360,000 /sf	270,000 /sf	75.00 gr. ac.	0	450	0	0.00 gr. ac.

Appendix A
2

Appendix A - Project Land Use Description

KALOKO MAKAI - BUSINESS PLAN

REAL ESTATE SCHEDULE Printed: 05/09/11

GENERAL ASSUMPTIONS MADE

USE CODES:

1 SFD
2 MF
3 COMMERCIAL
4 BUILT AMENITIES
5 PARK - OPEN SPACE
6 SCHOOL
7 CIRCULATION
8 INDUSTRIAL
9 CIVIC USE

USE	KONA VDG CODE	PARCEL I.D.	ZONING *	TYPE (See "Use Codes")	PARCEL SIZE (Ac)	MAX DENSITY ALLOWED	DENSITY BEING USED	# OF UNITS	COMMERCIAL RETAIL	COMMERCIAL OFFICE	COMMERCIAL LIGHT INDUS.	OTHER HOSPITAL BEDS	OTHER ELEMENTARY (Enrollment)	OTHER MIDDLE (Enrollment)	OTHER PARK/OPEN SPACE
		PHASE 3													
Single-Family	T3	T3-2		1	8.10	6.0 du/ac	4.0 du/ac	32 /du							
Single-Family	T3	T3-3		1	7.90	6.0 du/ac	3.0 du/ac	24 /du							
Single-Family	T3	T3-4		1	6.60	6.0 du/ac	3.0 du/ac	20 /du							
Single-Family	T3	T3-5		1	4.60	6.0 du/ac	4.0 du/ac	18 /du							
Single-Family	T3	T3-6		1	7.70	6.0 du/ac	4.0 du/ac	31 /du							
Single-Family	T3	T3-7		1	11.20	6.0 du/ac	4.0 du/ac	45 /du							
Single-Family	T3	T3-8		1	14.10	6.0 du/ac	4.0 du/ac	56 /du							
Single-Family	T3	T3-9		1	21.40	6.0 du/ac	4.0 du/ac	86 /du							
Single-Family	T3	T3-10		1	14.50	6.0 du/ac	4.0 du/ac	58 /du							
Single-Family	T3	T3-11		1	38.80	6.0 du/ac	4.0 du/ac	155 /du							
Multi-Family	T4	T4-1		2	5.30	12.0 du/ac	7.0 du/ac	37 /du							
Multi-Family	T4	T4-2		3	6.60	12.0 du/ac	7.0 du/ac	48 /du							
Retail Multi-Family	T4	T4-3		4	14.10	12.0 du/ac	7.0 du/ac	99 /du	25,000 /sf	0 /sf					
Multi-Family	T4	T4-4		5	10.00	12.0 du/ac	7.0 du/ac	70 /du							
TOD Park	PARK	P-1		5	10.00										
Elementary School		Elem School		9	12.00								450		
Dryland Forest	DRYLAND FOREST	Dryland Forest		9	150.00										
MF Affrdble Senior (15-ac) Retail (5.1-ac)	T4	T4-10		5	20.10	12.0 du/ac	7.0 du/ac	141 /du	25,000 /sf	0 /sf					
Single-Family	T3	T3-12		1	5.90	6.0 du/ac	6.0 du/ac	35 /du							
Fire Station Police Sub-station	FIRE STATION	Fire Station		9	3.00										
MF Affordable	T5	T5-12		2,3	18.80	30.0 du/ac	15.0 du/ac	282 /du	25,000 /sf	25,000 /sf					
Preserve/TOD Greenbelt	GREENBELT	Greenbelt		5	40.30										
Roadway	ROADWAYS			7											
	SUBTOTAL PHASE 3				431.00			1,235	75,000 /sf	25,000 /sf	0.00 gr. ac.	0	450	0	0.00 gr. ac.
		TOTAL			1,040.10			5,000	605,000 /sf	495,000 /sf	75.00 gr. ac.	150	900	600	0.00 gr. ac.

Appendix A 4

KALOKO MAKAI - BUSINESS PLAN

REAL ESTATE SCHEDULE Printed: 05/09/11

GENERAL ASSUMPTIONS MADE

USE CODES:

1 SFD
2 MF
3 COMMERCIAL
4 BUILT AMENITIES
5 PARK - OPEN SPACE
6 SCHOOL
7 CIRCULATION
8 INDUSTRIAL
9 CIVIC USE

USE	KONA VDG CODE	PARCEL I.D.	ZONING *	TYPE (See "Use Codes")	PARCEL SIZE (Ac)	MAX DENSITY ALLOWED	DENSITY BEING USED	# OF UNITS	COMMERCIAL RETAIL	COMMERCIAL OFFICE	COMMERCIAL LIGHT INDUS.	OTHER HOSPITAL BEDS	OTHER ELEMENTARY (Enrollment)	OTHER MIDDLE (Enrollment)	OTHER PARK/OPEN SPACE
		PHASE 2													
Single-Family	T3	T3-1		1	7.80	6.0 du/ac	5.0 du/ac	39 /du							
Multi-Family	T4	T4-5		2	15.90	12.0 du/ac	8.0 du/ac	127 /du							
Multi-Family	T4	T4-6		3	11.80	12.0 du/ac	8.0 du/ac	94 /du							
Multi-Family	T5	T5-1		2,3	8.00	30.0 du/ac	17.0 du/ac	136 /du							
Long-term Care Facility	T5	T5-2		2,3	13.90	30.0 du/ac	17.0 du/ac	238 /du							
Multi-Family	T5	T5-3		2,3	5.90	30.0 du/ac	15.0 du/ac	89 /du							
Multi-Family	T5	T5-4		2,3	17.30	30.0 du/ac	15.0 du/ac	260 /du							
Hospital/Medical Center	HOSPITAL/MED CTR	Hospital		9	40.00							150			
Transit Station TOD Square Lodge (5-ac - 120-units) Mixed-Use (5.5-ac) Multi-Family (5-ac)	T5	T5-7		2,3	16.50	30.0 du/ac	15.0 du/ac	233 /du	25,000 /sf	25,000 /sf					
Medical Office (10-ac) Multi-Family (14.9-ac)	T5	T5-8		2,3	24.50	30.0 du/ac	15.0 du/ac	374 /du	45,000 /sf	100,000 /sf					
Multi-Family (15-ac) Retail-Office (20.9-ac)	T5	T5-9		2,3	35.50	30.0 du/ac	10.0 du/ac	359 /du	100,000 /sf	75,000 /sf					
Middle School		Middle School		9	18.00									600	
TOD Park	PARK	P-2		5	13.10										
Roadway	ROADWAYS			7											
	OPEN SPACE			5											
	SUBTOTAL PHASE 2				228.00			1,946	170,000 /sf	200,000 /sf	0.00 gr. ac.	150	0	600	0.00 gr. ac.

Appendix A 3

Wilson Okamoto Corporation
1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counter:D4-5673, D4-5676
Counted By:SM, MM
Weather:Clear

File Name : QueKai AM
Site Code : 00000002
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Kaimhani drive Westbound					Queen Kaahumanu Highway Northbound					Eastbound	
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
06:00 AM	3	56	0	0	59	42	0	29	0	71	0	73	16	0	89	0	219
06:15 AM	6	46	0	0	52	69	0	40	0	109	0	68	21	0	109	0	270
06:30 AM	8	77	0	0	85	81	0	50	0	131	0	116	34	0	150	0	366
06:45 AM	7	86	0	0	93	122	0	68	0	190	0	134	21	0	155	0	438
Total	24	265	0	0	289	314	0	187	0	501	0	411	92	0	503	0	1293
07:00 AM	8	86	0	0	94	106	0	58	0	164	0	150	24	0	174	0	432
07:15 AM	4	96	0	0	100	127	0	59	0	186	0	137	27	0	164	0	450
07:30 AM	6	106	0	0	112	125	0	36	0	161	0	141	30	0	171	0	444
07:45 AM	6	113	0	0	119	114	0	56	0	170	0	105	31	0	136	0	425
Total	24	401	0	0	425	472	0	209	0	681	0	533	112	0	645	0	1751
08:00 AM	13	91	0	0	104	86	0	31	0	117	0	103	40	0	143	0	364
08:15 AM	4	109	0	0	113	61	0	23	0	84	0	134	36	0	170	0	367
08:30 AM	9	130	0	0	139	59	0	31	0	90	0	118	25	0	143	0	372
08:45 AM	10	125	0	0	135	68	0	28	0	96	0	148	30	0	178	0	409
Total	36	455	0	0	491	274	0	113	0	387	0	503	131	0	634	0	1512
Grand Total	84	1121	0	0	1205	1060	0	509	0	1569	0	1447	335	0	1782	0	4556
Apprch %	7	93	0	0		67.6	0	32.4	0		0	81.2	18.8	0			
Total %	1.8	24.6	0	0	26.4	23.3	0	11.2	0	34.4	0	31.8	7.4	0	39.1	0	

	Queen Kaahumanu Highway Southbound				Kaimhani drive Westbound				Queen Kaahumanu Highway Northbound				Eastbound	
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 06:45 AM														
06:45 AM	7	86	0	93	122	0	68	190	0	134	21	155	0	438
07:00 AM	8	86	0	94	106	0	58	164	0	150	24	174	0	432
07:15 AM	4	96	0	100	127	0	59	186	0	137	27	164	0	450
07:30 AM	6	106	0	112	125	0	36	161	0	141	30	171	0	444
Total Volume	25	374	0	399	480	0	221	701	0	562	102	664	0	1764
% App. Total	6.3	93.7	0		68.5	0	31.5		0	84.6	15.4			
PHF	.781	.882	.000	.891	.945	.000	.813	.922	.000	.937	.850	.954	.000	.950

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-3888, D4-3890
Counted By:AW, JW
Weather:Clear

File Name : QueHul AM
Site Code : 00000003
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Huikoa Drive Westbound					Queen Kaahumanu Highway Northbound					Eastbound	
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
06:00 AM	14	76	0	0	90	3	0	8	1	12	0	89	19	0	108	0	210
06:15 AM	22	88	0	0	110	5	0	20	1	26	0	126	15	0	140	0	276
06:30 AM	15	132	0	0	147	2	0	18	0	20	0	130	53	0	183	0	350
06:45 AM	30	160	0	0	190	6	0	25	0	31	0	160	44	0	204	0	425
Total	81	456	0	0	537	16	0	71	2	89	0	504	131	0	635	0	1261
07:00 AM	18	151	0	0	169	32	0	32	0	64	0	135	36	0	171	0	404
07:15 AM	18	150	0	0	168	19	0	22	0	41	0	154	29	0	183	0	392
07:30 AM	11	218	0	0	229	22	0	24	0	46	0	141	32	0	173	0	448
07:45 AM	10	195	0	0	205	18	0	25	0	43	0	134	31	0	165	0	413
Total	57	714	0	0	771	91	0	103	0	194	0	564	128	0	692	0	1657
08:00 AM	17	145	0	0	162	20	0	21	0	41	0	152	32	0	184	0	387
08:15 AM	22	146	0	0	168	16	0	28	0	44	0	145	37	0	182	0	394
08:30 AM	36	147	0	0	183	22	0	24	0	46	0	130	22	0	152	0	381
08:45 AM	24	171	0	0	195	27	0	25	0	52	0	147	34	0	181	0	428
Total	99	609	0	0	708	85	0	98	0	183	0	574	125	0	699	0	1590
Grand Total	237	1779	0	0	2016	192	0	272	2	466	0	1642	384	0	2026	0	4508
Apprch %	11.8	88.2	0	0		41.2	0	58.4	0.4		0	81	19	0			
Total %	5.3	39.5	0	0	44.7	4.3	0	6	0	10.3	0	36.4	8.5	0	44.9	0	

	Queen Kaahumanu Highway Southbound				Huikoa Drive Westbound				Queen Kaahumanu Highway Northbound				Eastbound	
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 06:45 AM														
06:45 AM	30	160	0	190	6	0	25	31	0	160	44	204	0	425
07:00 AM	18	151	0	169	32	0	32	64	0	135	36	171	0	404
07:15 AM	18	150	0	168	19	0	22	41	0	154	29	183	0	392
07:30 AM	11	218	0	229	22	0	24	46	0	141	32	173	0	448
Total Volume	77	679	0	756	79	0	103	182	0	590	141	731	0	1669
% App. Total	10.2	89.8	0		43.4	0	56.6		0	80.7	19.3			
PHF	.642	.779	.000	.825	.617	.000	.805	.711	.000	.922	.801	.898	.000	.931

Appendix B
4

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-5673, D4-5676
Counted By:SM, MM
Weather:Clear

File Name : QueKai PM
Site Code : 00000002
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Kalminani Drive Westbound					Queen Kaahumanu Highway Northbound					Eastbound	
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
03:00 PM	23	133	0	0	156	56	0	12	0	68	0	129	47	0	176	0	400
03:15 PM	33	176	0	0	209	44	0	19	0	63	0	113	66	0	179	0	451
03:30 PM	55	156	0	0	211	51	0	15	0	66	0	127	102	0	229	0	506
03:45 PM	47	163	0	0	210	33	0	17	0	50	0	137	84	0	221	0	481
Total	158	628	0	0	786	184	0	63	0	247	0	506	299	0	805	0	1838
04:00 PM	47	156	0	0	203	43	0	17	0	60	0	105	82	0	187	0	450
04:15 PM	51	148	0	0	199	53	0	20	0	73	0	128	112	0	240	0	512
04:30 PM	30	132	0	0	162	39	0	11	0	50	0	126	97	0	223	0	435
04:45 PM	43	161	0	0	204	40	0	22	0	62	0	141	97	0	238	0	504
Total	171	597	0	0	768	175	0	70	0	245	0	500	388	0	888	0	1901
05:00 PM	28	120	0	0	148	39	0	23	0	62	0	122	95	0	217	0	427
05:15 PM	32	121	0	0	153	32	0	11	0	43	0	124	93	0	217	0	413
05:30 PM	27	118	0	0	145	36	0	20	0	56	0	116	98	0	213	0	414
05:45 PM	29	107	0	0	136	35	0	10	0	45	0	134	91	0	225	0	406
Total	116	466	0	0	582	142	0	64	0	206	0	495	377	0	872	0	1660
Grand Total	445	1691	0	0	2136	501	0	197	0	693	0	1501	1064	0	2565	0	6399
Apprch %	20.8	79.2	0	0		71.8	0	28.2	0		0	58.6	41.5	0			
Total %	6.2	31.3	0	0	39.6	9.3	0	3.6	0	12.9	0	27.8	19.7	0	47.5	0	

	Queen Kaahumanu Highway Southbound				Kalminani Drive Westbound				Queen Kaahumanu Highway Northbound				Eastbound	
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:30 PM														
03:30 PM	55	156	0	211	51	0	15	66	0	127	102	229	0	506
03:45 PM	47	163	0	210	33	0	17	50	0	137	84	221	0	481
04:00 PM	47	156	0	203	43	0	17	60	0	105	82	187	0	450
04:15 PM	51	148	0	199	53	0	20	73	0	128	112	240	0	512
Total Volume	200	623	0	823	180	0	69	249	0	497	380	877	0	1849
% App. Total	24.3	75.7	0		72.3	0	27.7		0	56.7	43.3			
PHF	.909	.956	.000	.976	.849	.000	.863	.853	.000	.907	.848	.914	.000	.952

Appendix B
3

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D1-3889,
Counted By:JH, MO
Weather:Clear

File Name : QueHin AM
Site Code : 00000004
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Hina Lani Street Westbound					Queen Kaahumanu Highway Northbound					Eastbound	
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
06:00 AM	17	71	0	1	89	28	0	18	1	47	0	83	29	2	114	0	250
06:15 AM	16	77	0	0	93	23	0	40	0	63	0	111	31	0	142	0	298
06:30 AM	29	109	0	0	138	34	0	49	10	93	0	143	57	0	200	0	431
06:45 AM	26	117	0	0	143	34	0	54	3	91	0	161	82	0	243	0	477
Total	88	374	0	1	463	119	0	161	14	294	0	498	199	2	699	0	1456
07:00 AM	48	159	0	0	207	37	0	41	5	83	0	123	67	1	191	0	481
07:15 AM	37	174	0	0	211	53	0	47	5	105	0	121	67	2	190	0	506
07:30 AM	32	198	0	1	231	50	0	44	2	96	0	126	84	2	212	0	539
07:45 AM	50	188	0	0	238	46	0	40	9	95	0	102	96	1	199	0	532
Total	167	719	0	1	887	166	0	172	21	379	0	472	314	6	792	0	2058
08:00 AM	41	148	0	0	189	61	0	51	2	114	0	116	109	2	227	0	530
08:15 AM	38	146	0	0	182	60	0	63	1	124	0	128	84	3	215	0	521
08:30 AM	39	140	0	0	179	78	0	47	0	125	0	125	69	2	196	0	500
08:45 AM	55	154	0	0	209	58	0	47	0	105	0	141	95	0	236	0	550
Total	171	588	0	0	759	257	0	208	3	468	0	510	357	7	874	0	2101
Grand Total	426	1681	0	2	2109	582	0	541	38	1141	0	1480	870	15	2365	0	5615
Apprch %	20.2	79.7	0	0.1		49.3	0	47.4	3.3		0	62.6	36.8	0.6			
Total %	7.6	29.9	0	0	37.6	10	0	9.6	0.7	20.3	0	26.4	15.5	0.3	42.1	0	

	Queen Kaahumanu Highway Southbound				Hina Lani Street Westbound				Queen Kaahumanu Highway Northbound				Eastbound	
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:30 AM														
07:30 AM	32	198	0	230	50	0	44	94	0	126	84	210	0	534
07:45 AM	50	188	0	238	46	0	40	86	0	102	96	198	0	522
08:00 AM	41	148	0	189	61	0	51	112	0	116	109	225	0	526
08:15 AM	38	146	0	182	60	0	63	123	0	128	84	212	0	617
Total Volume	159	680	0	839	217	0	198	415	0	472	373	845	0	2099
% App. Total	19	81	0		52.3	0	47.7		0	55.9	44.1			
PHF	.795	.859	.000	.881	.889	.000	.786	.843	.000	.922	.856	.939	.000	.983

Appendix B
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Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-3888, D4-3890
Counted By:AW, JW
Weather:Clear

File Name : QueHul PM
Site Code : 00000003
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Hukoa Drive Westbound					Queen Kaahumanu Highway Northbound					Eastbound	
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
03:00 PM	17	236	0	0	253	20	0	22	0	42	0	148	12	0	160	0	455
03:15 PM	8	236	0	0	244	20	0	20	0	40	0	154	24	0	178	0	462
03:30 PM	17	206	0	3	226	23	0	26	0	49	0	167	19	0	186	0	461
03:45 PM	16	173	0	1	190	27	0	28	0	55	0	166	24	0	190	0	435
Total	58	851	0	4	913	90	0	96	0	186	0	635	79	0	714	0	1813
04:00 PM	17	216	0	0	233	31	0	30	0	61	0	159	15	0	174	0	468
04:15 PM	19	233	0	0	252	32	0	24	0	56	0	176	18	0	194	0	502
04:30 PM	7	226	0	0	233	27	0	20	0	47	0	197	17	0	214	0	494
04:45 PM	14	216	0	0	230	30	0	11	0	41	0	187	15	0	202	0	473
Total	57	891	0	0	948	120	0	85	0	205	0	719	65	0	784	0	1937
05:00 PM	18	180	0	0	198	14	0	28	0	42	0	191	14	0	205	0	445
05:15 PM	11	168	0	0	179	19	0	30	0	49	0	171	13	0	184	0	412
05:30 PM	17	169	0	0	186	13	0	11	0	24	0	213	10	0	223	0	433
05:45 PM	8	173	0	0	181	15	0	14	0	29	0	183	12	0	195	0	405
Total	54	690	0	0	744	61	0	83	0	144	0	758	49	0	807	0	1695
Grand Total	169	2432	0	4	2605	271	0	264	0	535	0	2112	193	0	2305	0	5445
Apprch %	6.5	93.4	0	0.2		50.7	0	49.3	0		0	91.6	8.4	0			
Total %	3.1	44.7	0	0.1	47.8	5	0	4.8	0	9.8	0	38.8	3.5	0	42.3	0	

	Queen Kaahumanu Highway Southbound				Hukoa Drive Westbound				Queen Kaahumanu Highway Northbound				Eastbound	
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 04:00 PM														
04:00 PM	17	216	0	233	31	0	30	61	0	159	15	174	0	468
04:15 PM	19	233	0	252	32	0	24	56	0	176	18	194	0	502
04:30 PM	7	226	0	233	27	0	20	47	0	197	17	214	0	494
04:45 PM	14	216	0	230	30	0	11	41	0	187	15	202	0	473
Total Volume	57	891	0	948	120	0	85	205	0	719	65	784	0	1937
% App. Total	6	94	0		58.5	0	41.5		0	91.7	8.3			
PHF	.750	.956	.000	.940	.938	.000	.708	.840	.000	.912	.903	.816	.000	.965

Appendix B
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Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter: D4-5671, D4-5672
Counted By:PL, SP
Weather:Clear

File Name : HinKan AM
Site Code : 00000005
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Southbound	Hina Lani Street Westbound					Kanalani Street Northbound					Hina Lani Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	6	19	0	1	26	27	0	2	0	29	0	12	35	0	47	102
06:15 AM	0	4	35	0	0	39	30	0	4	0	34	0	12	36	0	48	121
06:30 AM	0	7	53	0	0	60	31	0	3	0	34	0	9	76	0	85	179
06:45 AM	0	11	59	0	0	70	27	0	2	0	29	0	18	87	0	105	204
Total	0	28	166	0	1	195	115	0	11	0	126	0	51	234	0	285	606
07:00 AM	0	9	47	0	0	56	46	0	1	0	47	0	20	94	1	115	218
07:15 AM	0	5	48	0	1	54	45	0	2	0	47	0	33	70	6	109	210
07:30 AM	0	6	49	0	0	55	46	0	3	0	49	0	32	85	0	117	221
07:45 AM	0	11	45	0	1	57	44	0	3	0	47	0	33	101	1	135	239
Total	0	31	189	0	2	222	181	0	9	0	190	0	118	350	8	476	888
08:00 AM	0	8	53	0	0	61	59	0	4	0	63	0	33	105	0	138	262
08:15 AM	0	1	58	0	0	59	50	0	5	0	55	0	35	81	0	116	230
08:30 AM	0	4	50	0	0	54	63	0	1	0	64	0	32	66	2	100	218
08:45 AM	0	0	49	0	0	49	53	0	3	0	56	0	37	111	0	148	253
Total	0	13	210	0	0	223	225	0	13	0	238	0	137	363	2	502	963
Grand Total	0	72	565	0	3	640	521	0	33	0	654	0	306	947	10	1263	2457
Apprch %		11.2	88.3	0	0.5		94	0	6	0		0	24.2	75	0.8		
Total %	0	2.9	23	0	0.1	26	21.2	0	1.3	0	22.5	0	12.5	38.5	0.4	51.4	

	Southbound	Hina Lani Street Westbound				Kanalani Street Northbound				Hina Lani Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 08:00 AM														
08:00 AM	0	8	53	0	61	59	0	4	63	0	33	105	138	262
08:15 AM	0	1	58	0	59	50	0	5	55	0	35	81	116	230
08:30 AM	0	4	50	0	54	63	0	1	64	0	32	66	98	218
08:45 AM	0	0	49	0	49	53	0	3	56	0	37	111	148	253
Total Volume	0	13	210	0	223	225	0	13	238	0	137	363	500	961
% App. Total		5.8	94.2	0		94.5	0	5.5		0	27.4	72.6		
PHF	.000	.406	.905	.000	.914	.893	.000	.650	.930	.000	.926	.818	.845	.917

Appendix B

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:
Counted By:
Weather:

File Name : QueHin PM
Site Code : 00000004
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Hina Lani Street Westbound					Queen Kaahumanu Highway Northbound					Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	62	173	0	0	235	145	0	65	1	211	0	120	124	0	244	0	0	0	0	0	690
03:15 PM	62	188	0	3	253	116	0	61	2	179	0	140	143	0	283	0	0	0	0	0	715
03:30 PM	59	174	0	3	236	112	0	42	5	159	0	163	130	4	297	0	0	0	0	0	692
03:45 PM	50	185	0	4	239	106	0	62	7	175	0	156	124	3	283	0	0	0	0	0	697
Total	233	720	0	10	963	479	0	230	15	724	0	579	521	7	1107	0	0	0	0	0	2794
04:00 PM	45	183	0	3	231	113	0	69	8	190	0	111	138	1	248	0	0	0	0	0	669
04:15 PM	44	183	0	2	229	128	0	75	0	203	0	157	120	0	277	0	0	0	0	0	709
04:30 PM	61	166	0	2	229	115	0	70	8	193	0	166	130	0	296	0	0	0	0	0	718
04:45 PM	64	172	0	4	240	113	0	61	4	178	0	150	141	0	291	0	0	0	0	0	709
Total	214	704	0	11	929	469	0	275	20	764	0	584	527	1	1112	0	0	0	0	0	2805
05:00 PM	35	152	0	0	187	100	0	47	0	147	0	161	108	0	269	0	0	0	0	0	603
05:15 PM	35	130	0	5	170	114	0	67	1	182	0	132	97	0	229	0	0	0	0	0	581
05:30 PM	34	129	0	0	163	104	0	54	1	159	0	158	93	0	251	0	0	0	0	0	573
05:45 PM	50	118	0	0	168	78	0	49	1	128	0	132	67	1	200	0	0	0	0	0	496
Total	154	529	0	5	688	396	0	217	3	616	0	583	365	1	949	0	0	0	0	0	2253
Grand Total	601	1953	0	26	2580	1344	0	722	38	2104	0	1746	1413	9	3168	0	0	0	0	0	7852
Apprch %	23.3	75.7	0	1		63.9	0	34.3	1.8		0	55.1	44.6	0.3		0	0	0	0		
Total %	7.7	24.9	0	0.3	32.9	17.1	0	9.2	0.5	26.8	0	22.2	18	0.1	40.3	0	0	0	0	0	

	Queen Kaahumanu Highway Southbound					Hina Lani Street Westbound					Queen Kaahumanu Highway Northbound					Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	45	183	0	3	231	113	0	69	8	190	0	111	138	1	248	0	0	0	0	0	669
04:15 PM	44	183	0	2	229	128	0	75	0	203	0	157	120	0	277	0	0	0	0	0	709
04:30 PM	61	166	0	2	229	115	0	70	8	193	0	166	130	0	296	0	0	0	0	0	718
04:45 PM	64	172	0	4	240	113	0	61	4	178	0	150	141	0	291	0	0	0	0	0	709
Total Volume	214	704	0	11	929	469	0	275	20	764	0	584	527	1	1112	0	0	0	0	0	2805
% App. Total	23	75.8	0	1.2		61.4	0	36	2.6		0	52.5	47.4	0.1		0	0	0	0		
PHF	.838	.962	.000	.688	.968	.916	.000	.917	.625	.941	.000	.880	.934	.250	.939	.000	.000	.000	.000	.000	.977

Appendix B

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-5674, D4-5675
Counted By:CN, JM
Weather:Clear

File Name : HinKam AM
Site Code : 00000006
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Southbound	Hina Lani Street Westbound					Kamanu Street Northbound					Hina Lani Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	14	16	0	0	30	5	0	2	0	7	0	7	7	0	14	51
06:15 AM	0	14	31	0	0	45	5	0	1	1	7	0	4	7	0	11	63
06:30 AM	0	22	47	0	0	69	13	0	6	0	19	0	6	5	1	12	100
06:45 AM	0	32	57	0	0	89	14	0	3	0	17	0	4	12	0	16	122
Total	0	82	151	0	0	233	37	0	12	1	50	0	21	31	1	53	336
07:00 AM	0	19	31	0	0	50	20	0	9	0	29	0	7	15	0	22	101
07:15 AM	0	28	35	0	0	63	18	0	4	0	22	0	15	19	0	34	119
07:30 AM	0	21	28	0	0	49	20	0	10	0	30	0	13	11	0	24	103
07:45 AM	0	29	37	0	0	66	20	0	12	0	32	0	12	20	0	32	130
Total	0	97	131	0	0	228	78	0	35	0	113	0	47	65	0	112	453
08:00 AM	0	39	34	0	0	73	30	0	11	0	41	0	9	25	0	34	148
08:15 AM	0	13	27	0	0	40	37	0	16	0	53	0	14	27	0	41	134
08:30 AM	0	19	22	0	0	41	25	0	15	0	40	0	12	18	0	30	111
08:45 AM	0	26	21	0	0	47	29	0	6	0	35	0	12	27	0	39	121
Total	0	97	104	0	0	201	121	0	48	0	169	0	47	97	0	144	514
Grand Total	0	276	386	0	0	662	236	0	95	1	332	0	115	193	1	309	1303
Apprch %		41.7	58.3	0	0		71.1	0	28.6	0.3		0	37.2	62.5	0.3		
Total %	0	21.2	29.6	0	0	50.8	18.1	0	7.3	0.1	25.5	0	8.8	14.8	0.1	23.7	

	Southbound	Hina Lani Street Westbound				Kamanu Street Northbound				Hina Lani Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:45 AM														
07:45 AM	0	29	37	0	66	20	0	12	32	0	12	20	32	130
08:00 AM	0	39	34	0	73	30	0	11	41	0	9	25	34	148
08:15 AM	0	13	27	0	40	37	0	16	53	0	14	27	41	134
08:30 AM	0	19	22	0	41	25	0	15	40	0	12	18	30	111
Total Volume	0	100	120	0	220	112	0	54	166	0	47	90	137	523
% App. Total		45.5	54.5	0		67.5	0	32.5		0	34.3	65.7		
PHF	.000	.641	.811	.000	.753	.757	.000	.844	.783	.000	.839	.833	.835	.883

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-5671, D4-5672
Counted By:PL, SP
Weather:Clear

File Name : HinKan PM
Site Code : 00000005
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Southbound	Hina Lani Street Westbound					Kanalani Street Northbound					Hina Lani Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	3	113	0	0	116	52	0	10	0	62	0	54	122	0	176	354
03:15 PM	0	0	116	0	2	118	43	0	9	0	52	0	58	109	0	167	337
03:30 PM	0	1	110	0	0	111	56	0	15	0	71	0	42	139	1	182	364
03:45 PM	0	0	110	0	0	110	47	0	13	0	60	0	49	120	0	169	339
Total	0	4	449	0	2	455	198	0	47	0	245	0	203	490	1	694	1394
04:00 PM	0	5	120	0	0	125	54	0	19	0	73	0	53	121	3	177	375
04:15 PM	0	5	98	0	0	103	59	0	10	0	69	0	52	103	0	155	327
04:30 PM	0	7	102	0	1	110	42	0	19	0	61	0	33	124	0	157	328
04:45 PM	0	7	78	0	0	85	41	0	10	0	51	0	78	116	1	195	331
Total	0	24	398	0	1	423	196	0	58	0	254	0	216	464	4	684	1361
05:00 PM	0	3	83	0	0	86	55	0	12	0	67	0	40	99	0	139	292
05:15 PM	0	3	80	0	0	83	28	0	10	0	38	0	31	88	0	119	240
05:30 PM	0	2	71	0	0	73	56	0	6	0	62	0	45	82	0	127	262
05:45 PM	0	1	59	0	0	60	39	0	2	0	41	0	34	75	0	109	210
Total	0	9	293	0	0	302	178	0	30	0	208	0	150	344	0	494	1004
Grand Total	0	37	1140	0	3	1180	572	0	135	0	707	0	569	1298	5	1872	3759
Apprch %		3.1	96.6	0	0.3		80.9	0	19.1	0		0	30.4	69.3	0.3		
Total %	0	1	30.3	0	0.1	31.4	15.2	0	3.6	0	18.8	0	15.1	34.5	0.1	49.8	

	Southbound	Hina Lani Street Westbound				Kanalani Street Northbound				Hina Lani Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:15 PM														
03:15 PM	0	0	116	0	116	43	0	9	52	0	58	109	167	335
03:30 PM	0	1	110	0	111	56	0	15	71	0	42	139	181	363
03:45 PM	0	0	110	0	110	47	0	13	60	0	49	120	169	339
04:00 PM	0	5	120	0	125	54	0	19	73	0	53	121	174	372
Total Volume	0	6	456	0	462	200	0	56	256	0	202	489	691	1409
% App. Total		1.3	98.7	0		78.1	0	21.9		0	29.2	70.8		
PHF	.000	.300	.950	.000	.924	.893	.000	.737	.877	.000	.871	.879	.954	.947

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-5671, D4-5672
Counted By:PL, SP
Weather:Clear

File Name : MamHin AM
Site Code : 00000012
Start Date : 9/22/2010
Page No : 1

Groups Printed- Unshifted

	Mamalahoa Highway Southbound					Westbound	Mamalahoa Highway Northbound					Hina Lani Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	53	17	0	70	0	20	35	0	0	55	5	0	4	0	9	134
06:15 AM	0	85	19	0	104	0	20	44	0	0	64	12	0	3	0	15	183
06:30 AM	0	107	32	0	139	0	19	46	0	0	65	7	0	4	0	11	215
06:45 AM	0	192	53	0	245	0	29	56	0	0	85	3	0	13	0	16	346
Total	0	437	121	0	558	0	88	181	0	0	269	27	0	24	0	51	878
07:00 AM	0	241	29	0	270	0	22	66	0	0	88	7	0	14	0	21	379
07:15 AM	0	249	36	0	285	0	36	61	0	0	97	6	0	27	0	33	415
07:30 AM	0	244	25	0	269	0	23	62	0	0	85	22	0	22	0	44	398
07:45 AM	0	222	41	0	263	0	38	85	0	0	123	22	0	16	0	38	424
Total	0	956	131	0	1087	0	119	274	0	0	393	57	0	79	0	136	1616
08:00 AM	0	155	31	0	186	0	33	98	0	0	131	14	0	19	0	33	350
08:15 AM	0	116	25	0	140	0	27	89	0	0	116	14	0	10	0	24	280
08:30 AM	0	104	27	0	131	0	16	67	0	0	83	16	0	18	0	34	248
08:45 AM	0	99	36	0	135	0	19	60	0	0	79	17	0	6	0	23	237
Total	0	473	119	0	592	0	95	314	0	0	409	61	0	53	0	114	1115
Grand Total	0	1868	371	0	2237	0	302	769	0	0	1071	145	0	156	0	301	3609
Apprch %	0	83.4	16.6	0			28.2	71.8	0	0		48.2	0	51.8	0		
Total %	0	51.7	10.3	0	62	0	8.4	21.3	0	0	29.7	4	0	4.3	0	8.3	

	Mamalahoa Highway Southbound				Westbound	Mamalahoa Highway Northbound				Hina Lani Street Eastbound				
Start Time	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:00 AM														
07:00 AM	0	241	29	270	0	22	66	0	88	7	0	14	21	379
07:15 AM	0	249	36	285	0	36	61	0	97	6	0	27	33	415
07:30 AM	0	244	25	269	0	23	62	0	85	22	0	22	44	398
07:45 AM	0	222	41	263	0	38	85	0	123	22	0	16	38	424
Total Volume	0	956	131	1087	0	119	274	0	393	57	0	79	136	1616
% App. Total	0	87.9	12.1			30.3	69.7	0		41.9	0	58.1		
PHF	.000	.960	.799	.954	.000	.783	.806	.000	.799	.648	.000	.731	.773	.953

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-5674, D4-5675
Counted By:CN, JM
Weather:Clear

File Name : HinKam PM
Site Code : 00000006
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Southbound	Hina Lani Street Westbound					Kamanu Street Northbound					Hina Lani Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	26	12	0	0	38	97	0	46	0	143	0	13	26	0	39	219
03:15 PM	0	18	11	0	0	29	95	0	48	0	143	0	20	27	0	47	219
03:30 PM	0	26	19	0	0	45	94	0	52	0	146	0	26	26	0	52	243
03:45 PM	0	23	22	0	0	45	77	0	52	0	129	0	26	20	0	46	220
Total	0	93	64	0	0	157	363	0	198	0	561	0	85	98	0	183	901
04:00 PM	0	25	11	0	0	36	108	0	57	0	165	0	32	21	0	53	254
04:15 PM	0	20	14	0	0	34	94	0	62	0	156	0	32	27	0	59	249
04:30 PM	0	23	19	0	0	42	90	0	52	0	142	0	19	15	0	34	218
04:45 PM	0	15	8	0	0	23	73	0	49	0	122	0	37	34	0	71	216
Total	0	83	52	0	0	135	365	0	220	0	585	0	120	97	0	217	937
05:00 PM	0	19	12	0	0	31	76	0	46	1	123	0	25	20	0	45	199
05:15 PM	0	24	14	0	0	38	77	0	47	0	124	0	16	22	0	38	200
05:30 PM	0	15	9	0	0	24	62	0	34	0	96	0	26	25	0	51	171
05:45 PM	0	15	10	0	0	25	42	0	32	0	74	0	18	10	0	28	127
Total	0	73	45	0	0	118	257	0	159	1	417	0	85	77	0	162	697
Grand Total	0	249	161	0	0	410	985	0	577	1	1563	0	290	272	0	562	2535
Apprch %		60.7	39.3	0	0		63	0	36.9	0.1		0	51.6	48.4	0		
Total %	0	9.8	6.4	0	0	16.2	38.9	0	22.8	0	61.7	0	11.4	10.7	0	22.2	

	Southbound	Hina Lani Street Westbound				Kamanu Street Northbound				Hina Lani Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:30 PM														
03:30 PM	0	26	19	0	45	94	0	52	146	0	26	26	52	243
03:45 PM	0	23	22	0	45	77	0	52	129	0	26	20	46	220
04:00 PM	0	25	11	0	36	108	0	57	165	0	32	21	53	254
04:15 PM	0	20	14	0	34	94	0	62	156	0	32	27	59	249
Total Volume	0	94	66	0	160	373	0	223	596	0	116	94	210	966
% App. Total		58.8	41.2	0		62.6	0	37.4		0	55.2	44.8		
PHF	.000	.904	.750	.000	.889	.863	.000	.899	.903	.000	.906	.870	.890	.951

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-3891, D4-0768
Counted By:PP, JK
Weather:Clear

File Name : QueKea AM
Site Code : 00000007
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Kealakehe Parkway Westbound					Queen Kaahumanu Highway Northbound					Kealakehe Parkway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	9	60	21	1	81	8	2	15	0	25	7	128	10	0	145	2	2	7	0	11	262
06:15 AM	10	71	9	0	90	14	2	19	0	35	5	143	16	2	166	0	1	6	0	7	298
06:30 AM	19	84	8	1	112	17	3	28	0	48	15	170	31	0	216	5	0	2	0	7	383
06:45 AM	16	97	14	0	127	27	2	27	0	56	15	207	47	1	270	5	2	1	0	8	461
Total	54	302	52	2	410	66	9	89	0	164	42	648	104	3	797	12	5	16	0	33	1404
07:00 AM	25	137	6	0	169	28	2	23	0	53	11	169	39	0	219	3	0	3	0	6	446
07:15 AM	34	155	12	1	202	38	1	48	0	87	13	157	54	0	224	6	2	1	0	9	522
07:30 AM	40	166	13	1	220	55	7	25	0	87	17	153	66	0	236	4	1	11	0	16	559
07:45 AM	45	167	11	0	223	64	3	27	0	94	24	165	90	0	279	2	2	9	0	13	609
Total	144	625	42	2	813	185	13	123	0	321	65	644	249	0	958	15	5	24	0	44	2136
08:00 AM	39	131	12	0	182	72	7	38	0	117	14	153	84	2	253	5	2	3	0	10	562
08:15 AM	16	158	14	0	188	51	5	26	0	82	10	165	11	0	186	6	3	11	0	20	474
08:30 AM	7	178	8	0	193	21	0	14	0	35	27	175	24	0	226	1	4	13	0	18	472
08:45 AM	12	172	22	0	206	18	4	16	0	38	27	183	23	0	243	7	1	14	0	22	509
Total	74	637	56	0	767	162	16	94	0	272	78	636	142	2	908	19	10	41	0	70	2017
Grand Total	272	1564	150	4	1990	413	38	306	0	757	185	1978	495	5	2663	46	20	81	0	147	5557
Apprch %	13.7	78.6	7.5	0.2		54.6	5	40.4	0		6.9	74.3	18.6	0.2		31.3	13.6	55.1	0		
Total %	4.9	28.1	2.7	0.1	35.8	7.4	0.7	5.5	0	13.6	3.3	35.6	8.9	0.1	47.9	0.8	0.4	1.5	0	2.6	

	Queen Kaahumanu Highway Southbound					Kealakehe Parkway Westbound					Queen Kaahumanu Highway Northbound					Kealakehe Parkway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	34	155	12	1	202	38	1	48	0	87	13	157	54	0	224	6	2	1	0	9	522
07:30 AM	40	166	13	1	220	55	7	25	0	87	17	153	66	0	236	4	1	11	0	16	559
07:45 AM	45	167	11	0	223	64	3	27	0	94	24	165	90	0	279	2	2	9	0	13	609
08:00 AM	39	131	12	0	182	72	7	38	0	117	14	153	84	2	253	5	2	3	0	10	562
Total Volume	158	619	48	2	827	229	18	138	0	385	68	628	294	2	992	17	7	24	0	48	2252
% App. Total	19.1	74.8	5.8	0.2		59.5	4.7	35.8	0		6.9	63.3	29.6	0.2		35.4	14.6	50	0		
PHF	.878	.927	.923	.500	.927	.795	.643	.719	.000	.823	.708	.952	.817	.250	.889	.708	.875	.545	.000	.750	.924

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-5671, D4-5672
Counted By:PL, SP
Weather:Clear

File Name : MamHin PM
Site Code : 00000012
Start Date : 9/22/2010
Page No : 1

Groups Printed- Unshifted

	Mamalahoa Highway Southbound					Westbound	Mamalahoa Highway Northbound					Hina Lani Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	117	12	0	129	0	29	105	0	0	134	47	0	36	0	83	346
03:15 PM	0	94	13	0	107	0	20	112	0	0	132	48	0	41	0	89	328
03:30 PM	0	85	27	0	112	0	20	132	0	0	152	50	0	54	0	104	368
03:45 PM	0	92	25	0	117	0	26	122	0	0	148	42	0	52	0	94	359
Total	0	388	77	0	465	0	95	471	0	0	566	187	0	183	0	370	1401
04:00 PM	0	92	10	0	102	0	23	132	0	0	155	43	0	42	0	85	342
04:15 PM	0	122	24	0	146	0	6	125	0	0	133	55	0	62	0	117	396
04:30 PM	0	110	11	0	121	0	13	136	0	0	149	49	0	35	0	84	354
04:45 PM	0	100	8	0	108	0	20	131	0	0	151	42	0	49	0	91	350
Total	0	424	53	0	477	0	64	524	0	0	588	189	0	188	0	377	1442
05:00 PM	0	85	15	0	100	0	13	115	0	0	128	53	0	51	0	104	332
05:15 PM	0	118	12	0	130	0	11	128	0	0	139	40	0	24	0	64	333
05:30 PM	0	95	6	0	101	0	17	142	0	0	159	43	0	16	0	59	319
05:45 PM	0	101	14	0	115	0	9	113	0	0	122	40	0	16	0	56	293
Total	0	399	47	0	446	0	50	498	0	0	548	176	0	107	0	283	1277
Grand Total	0	1211	177	0	1388	0	209	1493	0	0	1702	552	0	478	0	1030	4120
Apprch %	0	87.2	12.8	0			12.3	87.7	0	0		53.6	0	46.4	0		
Total %	0	29.4	4.3	0	33.7	0	5.1	36.2	0	0	41.3	13.4	0	11.6	0	25	

	Mamalahoa Highway Southbound				Westbound	Mamalahoa Highway Northbound				Hina Lani Street Eastbound				
Start Time	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:30 PM														
03:30 PM	0	85	27	112	0	20	132	0	152	50	0	54	104	368
03:45 PM	0	92	25	117	0	26	122	0	148	42	0	52	94	359
04:00 PM	0	92	10	102	0	23	132	0	155	43	0	42	85	342
04:15 PM	0	122	24	146	0	6	125	0	133	55	0	62	117	396
Total Volume	0	391	86	477	0	77	511	0	588	190	0	210	400	1465
% App. Total	0	82	18			13.1	86.9	0		47.5	0	52.5		
PHF	.000	.801	.798	.817	.000	.740	.968	.000	.948	.864	.000	.847	.855	.925

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, HI 96826

Counter:D4-3891, D4-0768
Counted By:PP, JK
Weather:Clear

File Name : QueKea PM
Site Code : 00000007
Start Date : 9/21/2010
Page No : 1

Groups Printed- Unshifted

	Queen Kaahumanu Highway Southbound					Kealakehe Parkway Westbound					Queen Kaahumanu Highway Northbound					Kealakehe Parkway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	23	224	20	0	267	18	1	14	0	33	15	206	72	0	293	12	4	18	0	34	627
03:15 PM	19	235	16	0	270	68	3	13	0	84	11	180	46	0	237	16	3	9	0	28	619
03:30 PM	15	221	11	0	247	83	5	13	0	101	16	193	50	0	259	6	4	12	0	22	629
03:45 PM	10	248	10	0	268	41	4	21	0	66	18	214	41	0	273	25	2	21	0	48	655
Total	67	928	57	0	1052	210	13	61	0	284	60	793	209	0	1062	59	13	60	0	132	2530
04:00 PM	12	255	13	0	280	46	5	15	0	66	14	219	38	0	271	19	6	26	0	51	668
04:15 PM	15	267	10	0	292	40	6	5	0	51	12	225	27	0	264	9	7	12	0	28	635
04:30 PM	23	226	11	0	260	31	7	12	0	50	18	235	23	0	276	15	3	16	0	34	620
04:45 PM	16	206	14	0	236	36	0	17	0	53	5	204	26	0	235	12	3	25	0	40	564
Total	66	954	48	0	1068	153	18	49	0	220	49	883	114	0	1046	55	19	79	0	153	2487
05:00 PM	17	211	9	0	237	15	0	17	0	32	16	215	50	0	281	13	2	7	0	22	572
05:15 PM	15	176	14	0	205	33	4	11	0	48	18	179	46	0	243	14	4	13	0	31	527
05:30 PM	15	195	7	0	217	36	4	13	1	54	10	188	32	0	230	19	3	15	0	37	538
05:45 PM	9	170	6	0	185	29	6	16	0	51	5	164	28	0	197	16	5	8	1	30	463
Total	56	752	36	0	844	113	14	57	1	185	49	746	156	0	951	62	14	43	1	120	2100
Grand Total	169	2634	141	0	2964	476	45	167	1	689	158	2422	479	0	3059	176	46	182	1	405	7117
Apprch %	6.4	88.9	4.8	0		69.1	6.5	24.2	0.1		5.2	79.2	15.7	0		43.5	11.4	44.9	0.2		
Total %	2.7	37	2	0	41.6	6.7	0.6	2.3	0	9.7	2.2	34	6.7	0	43	2.5	0.6	2.6	0	5.7	

	Queen Kaahumanu Highway Southbound				Kealakehe Parkway Westbound				Queen Kaahumanu Highway Northbound				Kealakehe Parkway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:30 PM																	
03:30 PM	15	221	11	247	83	5	13	101	16	193	50	259	6	4	12	22	629
03:45 PM	10	248	10	268	41	4	21	66	18	214	41	273	25	2	21	48	655
04:00 PM	12	255	13	280	46	5	15	66	14	219	38	271	19	6	26	51	668
04:15 PM	15	267	10	292	40	6	5	51	12	225	27	264	9	7	12	28	635
Total Volume	52	991	44	1087	210	20	54	284	60	851	156	1067	59	19	71	149	2587
% App. Total	4.8	91.2	4		73.9	7	19		5.6	79.8	14.6		39.6	12.8	47.7		
PHF	.867	.928	.846	.931	.633	.833	.643	.703	.833	.948	.780	.977	.590	.679	.683	.730	.968

KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 33

MULTI-USE DEVELOPMENT

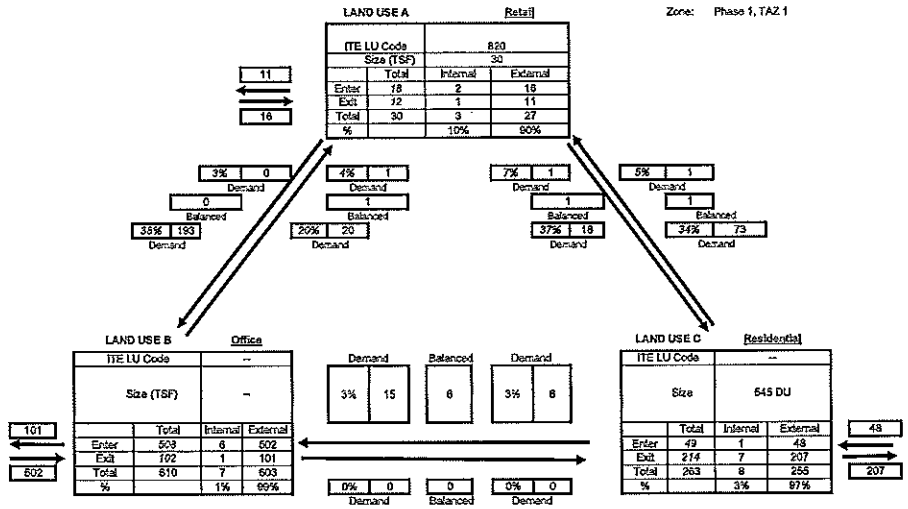
Project Name: Kaloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (AM)

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: AM Peak Hour

Zone: Phase 1, TAZ 1



Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	16	502	48	566	
Exit	11	101	207	319	INTERNAL CAPTURE
Total	27	603	255	885	
Single-Use Trip Gen. Est.	30	610	263	903	2%
Internal Capture	10%	1%	3%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

J:\2010\JB03140 Hawaii OMPO\Task 2 Traffic Study\Analysis\Trip Generation\Internal Capture\[JB03140 Internalcapture_Phase_1_TAZ1.xls]T 2-5-AM

KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 32

MULTI-USE DEVELOPMENT

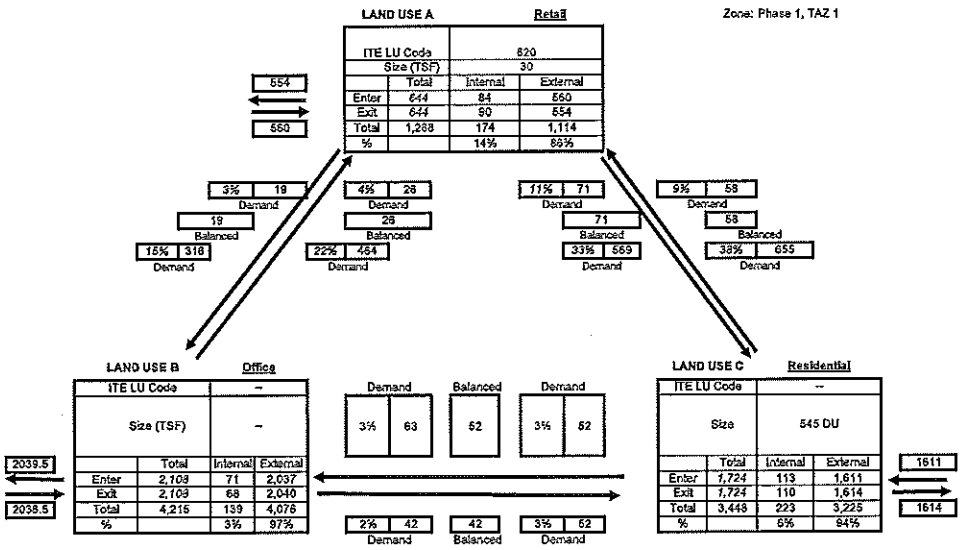
Project Name: Kaloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (DAILY)

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: Daily

Zone: Phase 1, TAZ 1



Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	560	2,037	1,611	4,208	
Exit	554	2,040	1,614	4,208	INTERNAL CAPTURE
Total	1,114	4,076	3,225	8,415	
Single-Use Trip Gen. Est.	1,288	4,215	3,448	8,951	6%
Internal Capture	14%	3%	6%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

J:\2010\JB03140 Hawaii OMPO\Task 2 Traffic Study\Analysis\Trip Generation\Internal Capture\[JB03140 Internalcapture_Phase_1_TAZ1.xls]T 2-4-Daily

KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 32

MULTI-USE DEVELOPMENT

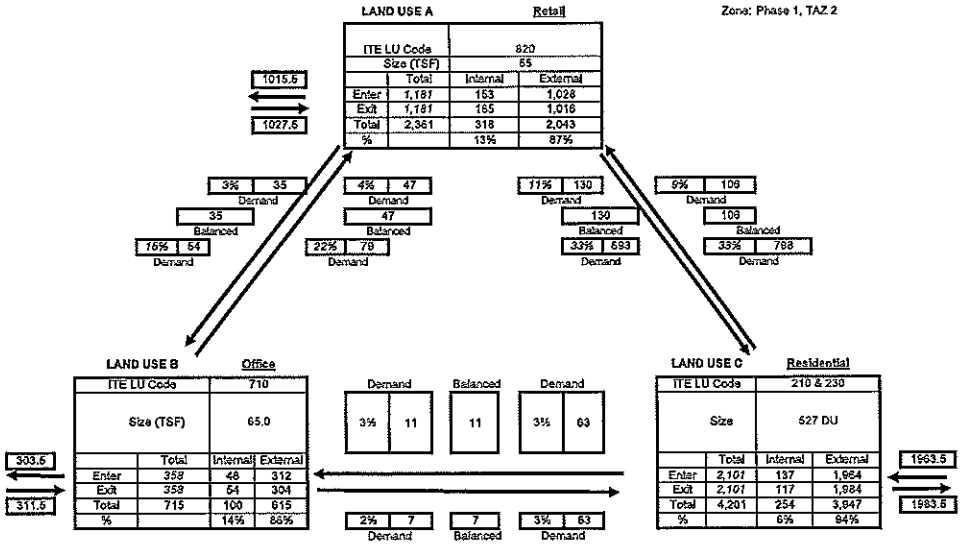
TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (DAILY)

Project Name: Kaloko Makai Village Project

Analyst FB
Date 6/9/2011

PN: JB03140
Time Period: Daily

Zone: Phase 1, TAZ 2



Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	1,028	312	1,964	3,303	
Exit	1,016	304	1,984	3,303	INTERNAL CAPTURE
Total	2,043	615	3,947	6,605	
Single-Use Trip Gen. Est.	2,361	715	4,201	7,277	9%
Internal Capture	13%	14%	6%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

J:\2010\JB03140 Hawaii OMPO\Task 2 Traffic Study\Analysis\Trip Generation\Internal Capture\[JB03140 Internalcapture_Phase_1_TAZ2.xls]T 2-4-Daily

KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 34

MULTI-USE DEVELOPMENT

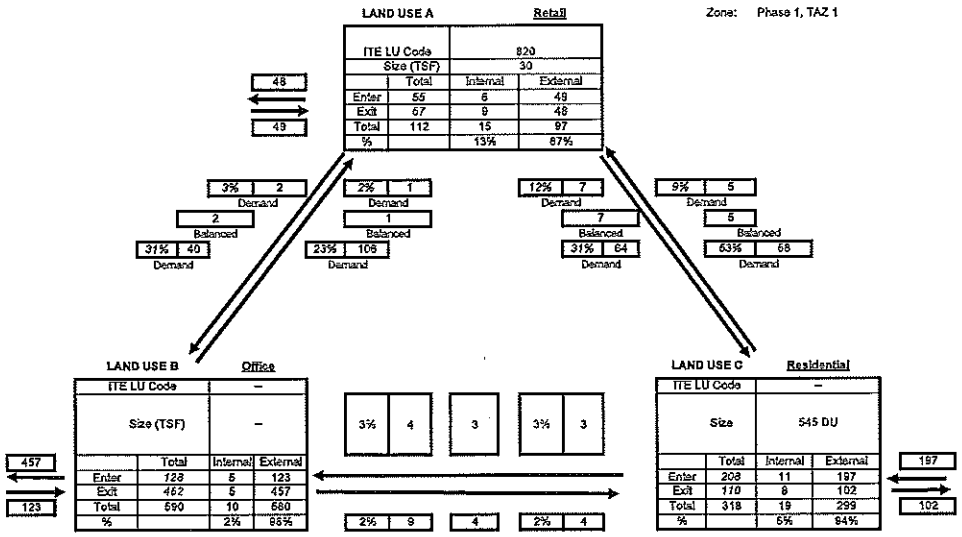
TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (PM)

Project Name: Kaloko Makai Village Project

Analyst FB
Date 6/9/2011

PN: JB03140
Time Period: PM Peak Hour

Zone: Phase 1, TAZ 1



Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	49	123	197	369	
Exit	48	457	102	607	INTERNAL CAPTURE
Total	97	580	299	976	
Single-Use Trip Gen. Est.	112	590	318	1020	4%
Internal Capture	13%	2%	6%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 34

MULTI-USE DEVELOPMENT

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (PM)

Project Name: Kaloko Makai Village Project

Analyst FB
Date 6/9/2011

PN: JB03140
Time Period: PM Peak Hour

Zone: Phase 1, TAZ 2

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	55		
	Total	Internal	External
Enter	100	11	89
Exit	104	15	89
Total	204	26	178
%		13%	87%

89 / 89

3% 3 Demand; 3 Balanced; 31% 5 Demand

2% 2 Demand; 2 Balanced; 23% 19 Demand

12% 12 Demand; 12 Balanced; 37% 84 Demand

9% 9 Demand; 9 Balanced; 63% 81 Demand

LAND USE B — Office

ITE LU Code	710		
Size (TSF)	65.0		
	Total	Internal	External
Enter	17	4	13
Exit	79	4	75
Total	96	8	88
%		8%	92%

75 / 13

3% 1 Demand; 1 Balanced; 3% 5 Demand

2% 2 Demand; 2 Balanced; 2% 5 Demand

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	527 DU		
	Total	Internal	External
Enter	271	14	257
Exit	152	10	142
Total	423	24	399
%		6%	94%

257 / 142

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	89	13	257	359	
Exit	89	75	142	306	INTERNAL CAPTURE
Total	178	88	399	665	
Single-Use Trip Gen. Est.	204	96	423	723	8%
Internal Capture	13%	8%	6%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 33

MULTI-USE DEVELOPMENT

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (AM)

Project Name: Kaloko Makai Village Project

Analyst FB
Date 6/9/2011

PN: JB03140
Time Period: AM Peak Hour

Zone: Phase 1, TAZ 2

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	55		
	Total	Internal	External
Enter	33	3	30
Exit	22	3	19
Total	55	6	49
%		11%	89%

19 / 30

3% 1 Demand; 1 Balanced; 38% 33 Demand

4% 1 Demand; 1 Balanced; 20% 3 Demand

7% 2 Demand; 2 Balanced; 37% 27 Demand

5% 2 Demand; 2 Balanced; 34% 68 Demand

LAND USE B — Office

ITE LU Code	710		
Size (TSF)	65.0		
	Total	Internal	External
Enter	63	4	84
Exit	13	1	12
Total	101	5	96
%		5%	95%

12 / 84

Demand 3% 3; Balanced 3; Demand 3% 8

Demand 0% 0; Balanced 0; Demand 0% 0

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	527 DU		
	Total	Internal	External
Enter	74	2	72
Exit	254	5	249
Total	328	7	321
%		2%	98%

72 / 249

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	30	84	72	186	
Exit	19	12	249	280	INTERNAL CAPTURE
Total	49	96	321	466	
Single-Use Trip Gen. Est.	55	101	328	484	4%
Internal Capture	11%	5%	2%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 33

MULTI-USE DEVELOPMENT

Project Name: Keloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (AM)

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: AM Peak Hour

Zone: Phase 1, TAZ 3

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	275		
	Total	Internal	External
Enter	168	15	153
Exit	107	10	97
Total	275	25	250
%		9%	91%

97 ⇄ 153

3% 3 Demand → 3 Balanced → 33% 299 Demand

4% 7 Demand → 7 Balanced → 20% 29 Demand

7% 7 Demand → 7 Balanced → 37% 18 Demand

6% 8 Demand → 8 Balanced → 34% 84 Demand

LAND USE B — Office

ITE LU Code	710/720/730		
Size (TSF)	283.9		
	Total	Internal	External
Enter	768	10	778
Exit	143	7	136
Total	931	17	914
%		2%	98%

138 ⇄ 778

Demand 3% 24 — Balanced 7 — Demand 3% 7

0% 0 Demand — 0 Balanced — 0% 0 Demand

LAND USE C — Residential

ITE LU Code	230		
Size	673 DU		
	Total	Internal	External
Enter	48	7	41
Exit	248	15	233
Total	296	22	274
%		7%	93%

41 ⇄ 233

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	153	778	41	972	
Exit	97	136	233	466	INTERNAL CAPTURE
Total	250	914	274	1438	
Single-Use Trip Gen. Est.	275	931	296	1502	4%
Internal Capture	9%	2%	7%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 32

MULTI-USE DEVELOPMENT

Project Name: Keloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (DAILY)

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: Daily

Zone: Phase 1, TAZ 3

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	275		
	Total	Internal	External
Enter	5,905	767	5,138
Exit	5,905	822	5,083
Total	11,810	1,589	10,221
%		13%	87%

5083 ⇄ 5138

3% 177 Demand → 177 Balanced → 15% 755 Demand

4% 238 Demand → 238 Balanced → 22% 1107 Demand

11% 650 Demand → 645 Balanced → 33% 645 Demand

9% 531 Demand → 531 Balanced → 39% 743 Demand

LAND USE B — Office

ITE LU Code	710/720/730		
Size (TSF)	283.9		
	Total	Internal	External
Enter	5,030	236	4,794
Exit	5,030	295	4,735
Total	10,060	531	9,529
%		5%	95%

4735 ⇄ 4794

Demand 3% 151 — Balanced 59 — Demand 3% 59

2% 101 Demand — 59 Balanced — 3% 59 Demand

LAND USE C — Residential

ITE LU Code	230		
Size	673 DU		
	Total	Internal	External
Enter	1,955	704	1,251
Exit	1,955	590	1,365
Total	3,909	1,294	2,615
%		33%	67%

1250.5 ⇄ 1364.5

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	5,138	4,794	1,251	11,183	
Exit	5,083	4,735	1,365	11,183	INTERNAL CAPTURE
Total	10,221	9,529	2,615	22,365	
Single-Use Trip Gen. Est.	11,810	10,060	3,909	25,779	13%
Internal Capture	13%	5%	33%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 32

MULTI-USE DEVELOPMENT

Project Name: Kaloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (DAILY)

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: Daily

Zone: Phase 2, TAZ 4

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	170		
	Total	Internal	External
Enter	5,905	767	5,138
Exit	5,905	827	5,078
Total	11,810	1,594	10,216
%		13%	87%

5078 / 5138

3% 177 Demand → 177 Balanced → 15% 550 Demand

4% 238 Demand → 238 Balanced → 22% 821 Demand

11% 650 Demand → 650 Balanced → 33% 1550 Demand

9% 531 Demand → 531 Balanced → 38% 1784 Demand

LAND USE B — Office

ITE LU Code	–		
Size (TSF)	–		
	Total	Internal	External
Enter	3,733	289	3,444
Exit	3,733	311	3,422
Total	7,466	600	6,866
%		8%	92%

3422 / 3444

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	1591 DU		
	Total	Internal	External
Enter	4,695	725	3,971
Exit	4,695	643	4,053
Total	9,391	1,368	8,023
%		15%	85%

3970.5 / 4052.5

Demand 3% 112 — Balanced 112 — Demand 3% 141

Demand 2% 75 — Balanced 75 — Demand 3% 141

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	5,138	3,444	3,971	12,553	
Exit	5,078	3,422	4,053	12,553	INTERNAL CAPTURE
Total	10,216	6,866	8,023	25,105	
Single-Use Trip Gen. Est.	11,810	7,466	9,391	28,667	12%
Internal Capture	13%	8%	15%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 34

MULTI-USE DEVELOPMENT

Project Name: Kaloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (PM)

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: PM Peak Hour

Zone: Phase 1, TAZ 3

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	275		
	Total	Internal	External
Enter	504	55	449
Exit	522	79	443
Total	1026	134	892
%		13%	87%

443 / 449

3% 16 Demand → 16 Balanced → 31% 31 Demand

2% 10 Demand → 10 Balanced → 23% 78 Demand

12% 63 Demand → 63 Balanced → 31% 73 Demand

9% 45 Demand → 45 Balanced → 53% 60 Demand

LAND USE B — Office

ITE LU Code	710/720/730		
Size (TSF)	283.9		
	Total	Internal	External
Enter	101	19	82
Exit	341	15	326
Total	442	34	408
%		8%	92%

326 / 82

LAND USE C — Residential

ITE LU Code	230		
Size	673 DU		
	Total	Internal	External
Enter	226	58	168
Exit	174	48	66
Total	350	116	234
%		33%	67%

168 / 66

3% 3 — 3 — 3% 3

2% 7 — 5 — 2% 5

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	449	82	168	699	
Exit	443	326	66	835	INTERNAL CAPTURE
Total	892	408	234	1534	
Single-Use Trip Gen. Est.	1026	442	350	1818	16%
Internal Capture	13%	8%	33%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 34

MULTI-USE DEVELOPMENT

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (PM)

Project Name: Kaloko Makai Village Project

Analyst: FB
Date: 6/8/2011

PN: JB03140
Time Period: PM Peak Hour
Zone: Phase 2, TAZ 4

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	170		
	Total	Internal	External
Enter	311	34	277
Exit	323	49	274
Total	634	83	551
%		13%	87%

274 / 277

3% 10 Demand; 10 Balanced; 31% 70 Demand

2% 6 Demand; 6 Balanced; 23% 124 Demand

12% 39 Demand; 39 Balanced; 31% 176 Demand

9% 28 Demand; 28 Balanced; 53% 147 Demand

LAND USE B — Office

ITE LU Code	–		
Size (TSF)	–		
	Total	Internal	External
Enter	226	17	209
Exit	537	17	520
Total	763	34	729
%		4%	96%

520 / 209

3% 7 | 7 | 3% 8

2% 11 | 11 | 2% 11

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	1591 DU		
	Total	Internal	External
Enter	569	50	519
Exit	277	35	242
Total	846	85	761
%		10%	90%

519 / 242

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	277	209	519	1005	
Exit	274	520	242	1036	INTERNAL CAPTURE
Total	551	729	761	2041	
Single-Use Trip Gen. Est.	634	763	846	2243	9%
Internal Capture	13%	4%	10%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 33

MULTI-USE DEVELOPMENT

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (AM)

Project Name: Kaloko Makai Village Project

Analyst: FB
Date: 6/8/2011

PN: JB03140
Time Period: AM Peak Hour
Zone: Phase 2, TAZ 4

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	170		
	Total	Internal	External
Enter	103	9	94
Exit	67	7	60
Total	170	16	154
%		9%	91%

60 / 84

3% 2 Demand; 2 Balanced; 35% 183 Demand

4% 4 Demand; 4 Balanced; 20% 28 Demand

7% 5 Demand; 5 Balanced; 37% 43 Demand

5% 6 Demand; 6 Balanced; 34% 203 Demand

LAND USE B — Office

ITE LU Code	–		
Size (TSF)	–		
	Total	Internal	External
Enter	431	16	465
Exit	142	4	138
Total	623	20	603
%		3%	97%

138 / 465

Demand 3% 14 | Balanced 14 | Demand 3% 18

0% 0 Demand | 0 Balanced | 0% 0 Demand

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	1591 DU		
	Total	Internal	External
Enter	116	5	111
Exit	596	19	577
Total	712	24	688
%		3%	97%

111 / 577

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	94	465	111	670	
Exit	60	138	577	775	INTERNAL CAPTURE
Total	154	603	688	1445	
Single-Use Trip Gen. Est.	170	623	712	1505	4%
Internal Capture	9%	3%	3%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 33

MULTI-USE DEVELOPMENT

Project Name: Kaloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (AM)

Analyst FR
Date 6/8/2011

PN: JB03140
Time Period: AM Peak Hour

Zone: Phase 3, TAZ 6

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	25		
	Total	Internal	External
Enter	15	1	14
Exit	10	1	9
Total	25	2	23
%		8%	92%

9 / 14

3% 0 Demand; 0 Balanced; 38% 0 Demand

4% 1 Demand; 0 Balanced; 20% 0 Demand

7% 1 Demand; 1 Balanced; 37% 29 Demand

5% 1 Demand; 1 Balanced; 34% 89 Demand

LAND USE B — Office

ITE LU Code	--		
Size (TSF)	--		
	Total	Internal	External
Enter	0	0	0
Exit	0	0	0
Total	0	0	0
%		#DIV/0!	#DIV/0!

0 / 0

Demand 3% 0; Balanced 0; Demand 3% 8

0% 0 Demand; 0 Balanced; 0% 0 Demand

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	524 DU		
	Total	Internal	External
Enter	79	1	78
Exit	263	1	262
Total	342	2	340
%		1%	99%

78 / 262

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	14	0	78	92	
Exit	9	0	262	271	INTERNAL CAPTURE
Total	23	0	340	363	
Single-Use Trip Gen. Est.	25	0	342	367	1%

Internal Capture 8% #DIV/0! 1%

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 32

MULTI-USE DEVELOPMENT

Project Name: Kaloko Makai Village Project

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (DAILY)

Analyst FR
Date 6/8/2011

PN: JB03140
Time Period: Daily

Zone: Phase 3, TAZ 6

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	25		
	Total	Internal	External
Enter	537	48	489
Exit	537	59	478
Total	1,074	107	967
%		10%	90%

478 / 489

3% 16 Demand; 0 Balanced; 15% 0 Demand

4% 21 Demand; 0 Balanced; 22% 0 Demand

11% 59 Demand; 59 Balanced; 33% 723 Demand

9% 48 Demand; 48 Balanced; 38% 832 Demand

LAND USE B — Office

ITE LU Code	--		
Size (TSF)	--		
	Total	Internal	External
Enter	0	0	0
Exit	0	0	0
Total	0	0	0
%		#DIV/0!	#DIV/0!

0 / 0

Demand 3% 0; Balanced 0; Demand 3% 68

2% 0 Demand; 0 Balanced; 3% 68 Demand

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	524 DU		
	Total	Internal	External
Enter	2,190	59	2,131
Exit	2,190	48	2,142
Total	4,378	107	4,272
%		2%	98%

2130.5 / 2141.5

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	489	0	2,131	2,620	
Exit	478	0	2,142	2,620	INTERNAL CAPTURE
Total	967	0	4,272	5,239	
Single-Use Trip Gen. Est.	1,074	0	4,379	5,453	4%

Internal Capture 10% #DIV/0! 2%

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 32

MULTI-USE DEVELOPMENT

TRIP GENERATION AND INTERNAL CAPTURE SUMMARY (DAILY)

Project Name: Kaloko Makai Village Project

Analyst: FB
Date: 6/8/2011

PN: JB03140
Time Period: Daily

Zone: Phase 3, TAZ 7

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	50		
	Total	Internal	External
Enter	1,074	140	934
Exit	1,074	150	924
Total	2,148	290	1,858
%		14%	86%

924 / 934

3% 32 Demand; 32 Balanced; 16% 35 Demand

4% 43 Demand; 43 Balanced; 22% 53 Demand

11% 118 Demand; 118 Balanced; 33% 448 Demand

9% 97 Demand; 97 Balanced; 38% 513 Demand

LAND USE B — Office

ITE LU Code	710 & 730		
Size (TSF)	--		
	Total	Internal	External
Enter	241	39	202
Exit	241	48	193
Total	482	87	395
%		18%	82%

193 / 202

Demand 3% 7; Balanced 7; Demand 3% 41

2% 5 Demand; 5 Balanced; 3% 41 Demand

LAND USE C — Residential

ITE LU Code	210/220/252		
Size	458 DU		
	Total	Internal	External
Enter	1,351	123	1,228
Exit	1,351	104	1,247
Total	2,701	227	2,474
%		8%	92%

1227.5 / 1248.5

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	934	202	1,228	2,364	
Exit	924	193	1,247	2,364	INTERNAL CAPTURE
Total	1,858	395	2,474	4,727	
Single-Use Trip Gen. Est.	2,148	482	2,701	5,331	11%
Internal Capture	14%	16%	8%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 34

MULTI-USE DEVELOPMENT

TRIP GENERATION AND INTERNAL CAPTURE SUMMARY (PM)

Project Name: Kaloko Makai Village Project

Analyst: FB
Date: 6/8/2011

PN: JB03140
Time Period: PM Peak Hour

Zone: Phase 3, TAZ 6

LAND USE A — Retail

ITE LU Code	820		
Size (TSF)	25		
	Total	Internal	External
Enter	46	4	42
Exit	47	6	41
Total	93	10	83
%		11%	89%

41 / 42

3% 1 Demand; 0 Balanced; 31% 0 Demand

2% 1 Demand; 0 Balanced; 23% 0 Demand

12% 6 Demand; 6 Balanced; 31% 89 Demand

9% 4 Demand; 4 Balanced; 53% 85 Demand

LAND USE B — Office

ITE LU Code	--		
Size (TSF)	--		
	Total	Internal	External
Enter	0	0	0
Exit	0	0	0
Total	0	0	0
%		#DIV/0!	#DIV/0!

0 / 0

3% 0; 0; 3% 5

2% 0; 0; 2% 6

LAND USE C — Residential

ITE LU Code	210 & 230		
Size	524 DU		
	Total	Internal	External
Enter	287	6	281
Exit	160	4	156
Total	447	10	437
%		2%	98%

281 / 156

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	42	0	281	323	
Exit	41	0	156	197	INTERNAL CAPTURE
Total	83	0	437	520	
Single-Use Trip Gen. Est.	93	0	447	540	4%
Internal Capture	11%	#DIV/0!	2%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

J:\2010\JB03140 Hawaii OMPO\Task 2 Traffic Study\Analysis\Trip Generation\Internal Capture\[JB03140 Internalcapture_Phase_3_TAZ6.xls]T 2-6-PM

KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 34

MULTI-USE DEVELOPMENT

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (PM)

Project Name: Kaloko Makai Village Project

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: PM Peak Hour

Zone: Phase 3, TAZ 7

LAND USE A — **Retail**

ITE LU Code	820		
Size (TSF)	50		
	Total	Internal	External
Enter	92	10	82
Exit	94	13	81
Total	188	23	163
%		12%	88%

81 / 82

3% 3 Demand; 2 Balanced; 31% 2 Demand

2% 2 Demand; 2 Balanced; 23% 8 Demand

12% 11 Demand; 11 Balanced; 31% 46 Demand

9% 8 Demand; 8 Balanced; 53% 45 Demand

LAND USE B — **Office**

ITE LU Code	710 & 730		
Size (TSF)	--		
	Total	Internal	External
Enter	7	2	5
Exit	34	3	31
Total	41	5	36
%		12%	88%

31 / 5

3% 0 — 0 — 3% 3

2% 1 — 1 — 2% 3

LAND USE C — **Residential**

ITE LU Code	210/220/252		
Size	458 DU		
	Total	Internal	External
Enter	149	12	137
Exit	84	8	76
Total	233	20	213
%		9%	91%

137 / 76

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	82	5	137	224	
Exit	81	31	76	188	INTERNAL CAPTURE
Total	163	36	213	412	
Single-Use Trip Gen. Est.	188	41	233	460	10%
Internal Capture	12%	12%	9%		

Input data

Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

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KOA CORPORATION
PLANNING & ENGINEERING

TABLE C - 33

MULTI-USE DEVELOPMENT

TRIP GENERATION
AND INTERNAL CAPTURE SUMMARY (AM)

Project Name: Kaloko Makai Village Project

Analyst FB
Date 6/8/2011

PN: JB03140
Time Period: AM Peak Hour

Zone: Phase 3, TAZ 7

LAND USE A — **Retail**

ITE LU Code	820		
Size (TSF)	50		
	Total	Internal	External
Enter	30	3	27
Exit	20	2	18
Total	50	5	45
%		10%	90%

18 / 27

3% 1 Demand; 1 Balanced; 38% 19 Demand

4% 1 Demand; 1 Balanced; 20% 2 Demand

7% 1 Demand; 1 Balanced; 37% 18 Demand

5% 2 Demand; 2 Balanced; 34% 50 Demand

LAND USE B — **Office**

ITE LU Code	710 & 730		
Size (TSF)	--		
	Total	Internal	External
Enter	49	2	47
Exit	8	1	7
Total	57	3	54
%		5%	95%

7 / 47

Demand 3% 1 — Balanced 1 — Demand 3% 4

0% 0 Demand — 0 Balanced — 0% 0 Demand

LAND USE C — **Residential**

ITE LU Code	210/220/252		
Size	458 DU		
	Total	Internal	External
Enter	42	1	41
Exit	146	3	143
Total	188	4	184
%		2%	98%

41 / 143

Net External Trips fro Multi-Use Development					
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	27	47	41	115	
Exit	18	7	143	168	INTERNAL CAPTURE
Total	45	54	184	283	
Single-Use Trip Gen. Est.	50	57	188	295	4%
Internal Capture	10%	5%	2%		

Input data

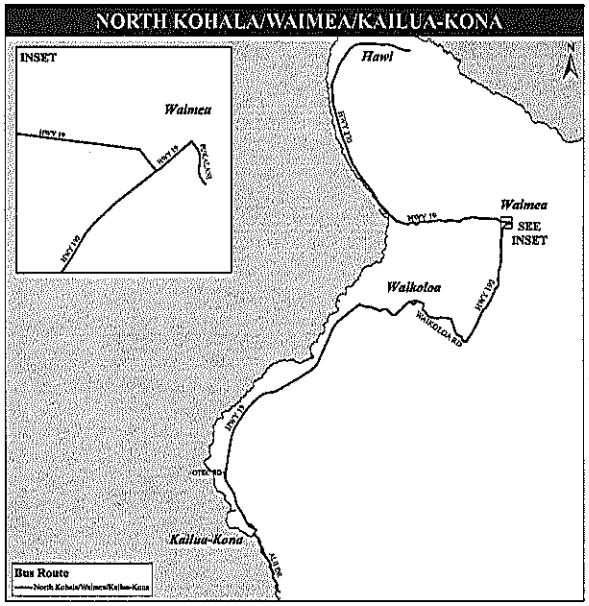
Source: ITE Trip Generation Handbook, Chapter 7 - Multi-Use Development

J:\2010\JB03140 Hawaii OMPO\Task 2 Traffic Study\Analysis\Trip Generation\Internal Capture\[JB03140 Internalcapture_Phase_3_TAZ7.xls]T 2-5-AM

Regional Ambient Growth Traffic on Highways

Highway	Ambient	AM Peak Hour		PM Peak Hour	
		North (In)	Southbound (Out)	North (In)	Southbound (Out)
SR-19 Queen Kaahumanu Hwy.	Existing	562	374	497	623
	15%	84	56	75	93
	51%	287	191	253	318
	99%	556	370	492	617
SR-190 Mamalahoa Hwy.	Existing	274	956	511	391
	15%	41	143	77	59
	51%	140	488	261	199
	99%	271	946	506	387
Ane Keohokalole Hwy.	Existing	29	38	23	29
	15%	4	6	3	4
	51%	15	19	12	15
	99%	29	38	23	29
Total Volume	Existing	865	1368	1031	1043
	2015	129	205	155	156
	2025	442	698	526	532
	2035	856	1354	1021	1033

Appendix E - Bus Route Map and Schedule



COUNTY OF HAWAII
MASS TRANSIT AGENCY
961-8744
NORTH KOHALA/ WAIMEA/KAILUA-KONA BUS SCHEDULE

In consideration of others and for your safety:

1. Shirts and footwear are required.
2. No flammable, explosive or toxic material.
3. No smoking, consumption of food or beverage.
4. Discarding of liter.
5. Expectorating or spitting.
6. The playing of radios, tape players, dvd players, and cell phones are prohibited without headphones.
7. Refrain from horseplaying, yelling or talking loudly.
8. The following items are prohibited unless prior permission is granted:
   a. Bodyboards
9. $1.00 charge for pets (except service animals) provided they are kept in an enclosed container or cage
10. $1.00 charge per item larger than 16" x 18" or more than one item that cannot fit underneath your seat. $1.00 charge for bicycle.
11. Please utilize designated bus stop zones whenever possible.

How to board the bus:

1. Wait on the proper side of the roadway for the bus.
2. Flag the bus (please call for bus stop information).
3. Wait until the bus makes a complete stop.
4. Boarding will be denied if passengers appear to be intoxicated on liquor or drugs; engaged in activities that violate any other law or ordinance.

How to exit the bus:

1. Before reaching your desired "get off" spot, pull cord located by the window of the bus.
2. Remain seated until the bus comes to a complete stop.
3. Exit from front of bus.

DISCLAIMER: The County of Hawaii will not be responsible for any inconvenience, expense, or damages resulting from the failure to depart or arrive at stated times or for any items brought on the bus.

For more information visit www.hatsonline.org

County of Hawaii is an Equal Opportunity Employer and Provider

NORTH KOHALA/WAIMEA/KAILUA-KONA

Effective 7/01/2010

Operates Monday through Friday

North Kohala/Waimea/Kenuhou

Kapaau Dispensary	Hawi Intersection	Kawaihae Road	Highway 19 & Highway 250 Intersection	Parker Square	Parker School (across by church)	Parker Ranch Shopping Center (back)	Waimea Park	Waikoloa Village Post Office	Kmart	Alii Drive	Kenuhou Shopping Center
6:45	6:50	7:15	7:30	7:35	7:40	7:45	8:20	8:45	9:30	9:40	9:50

Kenuhou/Waimea/North Kohala

***BOLD = MORNINGS

Kenuhou Shopping Center	Alii Drive	Kmart	Waikoloa Village Post Office	Parker Ranch Shopping Center (back)	Parker School	Waimea Park	HPA Lower Campus	Highway 19 & Highway 250 Intersection	Kawaihae Road	Hawi Intersection	Kapaau Dispensary
1:35	1:50	2:00	2:45	3:25	3:30	3:35	3:40	3:45	4:00	4:50	4:55

****SCHEDULE BELOW OPERATES SATURDAY ONLY****

North Kohala to Kenuhou shopping Center

Kapaau Dispensary	Hawi Intersection	Waikoloa Village	Kmart	Walmart	Alii Drive	Kenuhou Shopping Center
9:15	9:20	10:05	11:15	11:25	11:30	11:45

***BOLD = MORNINGS

Kenuhou to North Kohala Shopping Center

Kenuhou Shopping Center	Alii Drive	Walmart	Kmart	Waikoloa Post Office	Hawi Intersection	Kapaau Dispensary
2:30	2:40	3:00	3:10	3:55	4:30	4:35

For more information call Mass Transit @ 961-8744

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.26	1.00
Satd. Flow (perm)	1770	1583	1863	1583	478	1863
Volume (vph)	480	221	562	102	25	374
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	240	611	111	27	407
RTOR Reduction (vph)	0	112	0	59	0	0
Lane Group Flow (vph)	522	128	611	52	27	407
Turn Type		Perm		Perm	Perm	
Protected Phases	8		2			6
Permitted Phases		8		2	6	
Actuated Green, G (s)	17.3	17.3	22.1	22.1	22.1	22.1
Effective Green, g (s)	17.3	17.3	22.1	22.1	22.1	22.1
Actuated g/C Ratio	0.36	0.36	0.47	0.47	0.47	0.47
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	646	578	869	738	223	869
v/s Ratio Prot	c0.29		c0.33			0.22
v/s Ratio Perm		0.08		0.03	0.06	
v/c Ratio	0.81	0.22	0.70	0.07	0.12	0.47
Uniform Delay, d1	13.6	10.4	10.0	7.0	7.2	8.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	7.4	0.2	4.7	0.2	1.1	1.8
Delay (s)	20.9	10.6	14.8	7.2	8.3	10.4
Level of Service	C	B	B	A	A	B
Approach Delay (s)	17.7		13.6			10.3
Approach LOS	B		B			B

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	47.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	79	103	590	141	77	679
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	86	112	641	153	84	738
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1547	641			641	
vC1, stage 1 conf vol	641					
vC2, stage 2 conf vol	905					
vCu, unblocked vol	1547	641			641	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	76	76			91	
cM capacity (veh/h)	351	475			943	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	198	641	153	84	738
Volume Left	86	0	0	84	0
Volume Right	112	0	153	0	0
cSH	810	1700	1700	943	1700
Volume to Capacity	0.24	0.38	0.09	0.09	0.43
Queue Length 95th (ft)	24	0	0	7	0
Control Delay (s)	16.5	0.0	0.0	9.2	0.0
Lane LOS	C			A	
Approach Delay (s)	16.5	0.0		0.9	
Approach LOS	C				

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	49.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.97	1.00	0.97	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1541	1863	1530	1767	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.31	1.00
Satd. Flow (perm)	1770	1541	1863	1530	569	1863
Volume (vph)	217	198	472	373	159	680
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	236	215	513	405	173	739
RTOR Reduction (vph)	0	169	0	204	0	0
Lane Group Flow (vph)	236	46	513	201	173	739
Confl. Peds. (#/hr)		14		8	8	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	12.1	12.1	28.3	28.3	37.0	37.0
Effective Green, g (s)	12.1	12.1	28.3	28.3	37.0	37.0
Actuated g/C Ratio	0.21	0.21	0.50	0.50	0.65	0.65
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	375	327	923	758	467	1207
v/s Ratio Prot	c0.13		0.28		0.03	c0.40
v/s Ratio Perm		0.03		0.13	0.21	
v/c Ratio	0.63	0.14	0.56	0.26	0.37	0.61
Uniform Delay, d1	20.5	18.3	10.0	8.4	5.4	5.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.3	0.2	2.4	0.9	0.5	2.3
Delay (s)	23.8	18.5	12.4	9.2	5.9	8.2
Level of Service	C	B	B	A	A	A
Approach Delay (s)	21.2		11.0			7.7
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	11.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	57.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	137	363	13	210	225	13
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	149	395	14	228	245	14
Pedestrians					2	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						6
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			545		293	151
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			545		293	151
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		63	98
cM capacity (veh/h)			1018		663	867

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	149	395	90	152	259
Volume Left	0	0	14	0	245
Volume Right	0	395	0	0	14
cSH	1700	1700	1018	1700	702
Volume to Capacity	0.09	0.23	0.01	0.09	0.37
Queue Length 95th (ft)	0	0	1	0	42
Control Delay (s)	0.0	0.0	1.4	0.0	13.3
Lane LOS			A		B
Approach Delay (s)	0.0		0.5		13.3
Approach LOS					B

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	35.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	47	90	100	120	112	54
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	51	98	109	130	122	59
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						14
Median type					TWLTL	
Median storage veh)					5	
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			51		399	51
vC1, stage 1 conf vol					51	
vC2, stage 2 conf vol					348	
vCu, unblocked vol			51		399	51
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)			2.2		3.5	3.3
p0 queue free %			93		82	94
cM capacity (veh/h)			1555		665	1017

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	51	98	109	130	180
Volume Left	0	0	109	0	122
Volume Right	0	98	0	0	59
cSH	1700	1700	1555	1700	985
Volume to Capacity	0.03	0.06	0.07	0.08	0.18
Queue Length 95th (ft)	0	0	6	0	17
Control Delay (s)	0.0	0.0	7.5	0.0	10.7
Lane LOS			A		B
Approach Delay (s)	0.0		3.4		10.7
Approach LOS					B

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	25.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.15	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	284	1863	1863	1583
Volume (vph)	57	79	119	274	956	131
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	62	86	129	298	1039	142
RTOR Reduction (vph)	0	79	0	0	0	20
Lane Group Flow (vph)	62	7	129	298	1039	122
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	7.4	7.4	72.0	72.0	63.8	63.8
Effective Green, g (s)	7.4	7.4	72.0	72.0	63.8	63.8
Actuated g/C Ratio	0.08	0.08	0.82	0.82	0.73	0.73
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	150	134	305	1535	1360	1156
v/s Ratio Prot	c0.04		c0.02	0.16	c0.56	
v/s Ratio Perm		0.00	0.33			0.08
v/c Ratio	0.41	0.05	0.42	0.19	0.76	0.11
Uniform Delay, d1	37.9	36.8	9.3	1.6	7.2	3.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.8	0.2	0.9	0.3	4.1	0.2
Delay (s)	39.8	37.0	10.2	1.9	11.3	3.6
Level of Service	D	D	B	A	B	A
Approach Delay (s)	38.1			4.4	10.4	
Approach LOS	D			A	B	

Intersection Summary			
HCM Average Control Delay	11.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	87.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1800	1583		1780	1583	1769	1863	1548	1769	1863	1549
Flt Permitted		0.78	1.00		0.72	1.00	0.24	1.00	1.00	0.19	1.00	1.00
Satd. Flow (perm)		1450	1583		1347	1583	454	1863	1548	356	1863	1549
Volume (vph)	17	7	24	229	18	138	68	628	294	158	619	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	249	20	150	74	683	320	172	673	52
RTOR Reduction (vph)	0	0	20	0	0	114	0	0	164	0	0	25
Lane Group Flow (vph)	0	26	6	0	269	36	74	683	156	172	673	27
Confl. Peds. (#/hr)							2		2	2		2
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		14.1	14.1		14.1	14.1	30.7	28.4	28.4	33.7	29.9	29.9
Effective Green, g (s)		14.1	14.1		14.1	14.1	30.7	28.4	28.4	33.7	29.9	29.9
Actuated g/C Ratio		0.24	0.24		0.24	0.24	0.53	0.49	0.49	0.58	0.51	0.51
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		351	383		326	383	291	908	754	298	955	794
v/s Ratio Prot							0.01	c0.37		c0.04	0.36	
v/s Ratio Perm		0.02	0.00		c0.20	0.02	0.12		0.10	0.30		0.02
v/c Ratio		0.07	0.02		0.83	0.09	0.25	0.75	0.21	0.58	0.70	0.03
Uniform Delay, d1		17.1	16.8		20.9	17.1	8.1	12.1	8.5	8.5	10.8	7.0
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.1	0.0		15.5	0.1	0.5	5.7	0.6	2.7	4.4	0.1
Delay (s)		17.2	16.8		36.4	17.3	8.5	17.8	9.1	11.2	15.2	7.1
Level of Service		B	B		D	B	A	B	A	B	B	A
Approach Delay (s)		17.0			29.6			14.6			14.0	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	17.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	58.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.30	1.00
Satd. Flow (perm)	1770	1583	1863	1583	560	1863
Volume (vph)	180	69	497	380	200	623
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	75	540	413	217	677
RTOR Reduction (vph)	0	62	0	199	0	0
Lane Group Flow (vph)	196	13	540	214	217	677
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	9.4	9.4	28.7	28.7	38.0	38.0
Effective Green, g (s)	9.4	9.4	28.7	28.7	38.0	38.0
Actuated g/C Ratio	0.17	0.17	0.52	0.52	0.69	0.69
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	300	269	965	820	500	1278
v/s Ratio Prot	c0.11		0.29		0.04	c0.36
v/s Ratio Perm		0.01		0.14	0.26	
v/c Ratio	0.65	0.05	0.56	0.26	0.43	0.53
Uniform Delay, d1	21.5	19.3	9.1	7.4	4.7	4.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.0	0.1	2.3	0.8	0.6	1.6
Delay (s)	26.5	19.3	11.4	8.2	5.3	5.9
Level of Service	C	B	B	A	A	A
Approach Delay (s)	24.5		10.0			5.7
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	10.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	55.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	57.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	120	85	719	65	57	891
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	130	92	782	71	62	968
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1874	782			782	
vC1, stage 1 conf vol	782					
vC2, stage 2 conf vol	1092					
vCu, unblocked vol	1874	782			782	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	55	77			93	
cM capacity (veh/h)	290	395			836	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	223	782	71	62	968
Volume Left	130	0	0	62	0
Volume Right	92	0	71	0	0
cSH	496	1700	1700	836	1700
Volume to Capacity	0.45	0.46	0.04	0.07	0.57
Queue Length 95th (ft)	57	0	0	6	0
Control Delay (s)	22.9	0.0	0.0	9.6	0.0
Lane LOS	C			A	
Approach Delay (s)	22.9	0.0		0.6	
Approach LOS	C				

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	60.2%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.96	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1524	1863	1548	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.13	1.00
Satd. Flow (perm)	1770	1524	1863	1548	239	1863
Volume (vph)	469	275	584	527	214	704
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	510	299	635	573	233	765
RTOR Reduction (vph)	0	204	0	340	0	0
Lane Group Flow (vph)	510	95	635	233	233	765
Confl. Peds. (#/hr)		20		1	1	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	21.9	21.9	28.0	28.0	39.0	39.0
Effective Green, g (s)	21.9	21.9	28.0	28.0	39.0	39.0
Actuated g/C Ratio	0.32	0.32	0.41	0.41	0.57	0.57
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	563	484	757	629	291	1055
v/s Ratio Prot	c0.29		0.34		0.08	c0.41
v/s Ratio Perm		0.06		0.15	c0.37	
v/c Ratio	0.91	0.20	0.84	0.37	0.80	0.73
Uniform Delay, d1	22.5	17.1	18.4	14.3	12.6	11.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	18.1	0.2	10.8	1.7	14.5	4.3
Delay (s)	40.6	17.3	29.2	16.0	27.1	15.4
Level of Service	D	B	C	B	C	B
Approach Delay (s)	32.0		22.9			18.1
Approach LOS	C		C			B

Intersection Summary			
HCM Average Control Delay	23.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	68.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	202	489	6	456	200	56
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	220	532	7	496	217	61
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						6
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			755		484	224
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			755		484	224
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		57	92
cM capacity (veh/h)			848		506	777

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	220	532	172	330	278
Volume Left	0	0	7	0	217
Volume Right	0	532	0	0	61
cSH	1700	1700	848	1700	647
Volume to Capacity	0.13	0.31	0.01	0.19	0.43
Queue Length 95th (ft)	0	0	1	0	54
Control Delay (s)	0.0	0.0	0.4	0.0	15.8
Lane LOS			A		C
Approach Delay (s)	0.0		0.1		15.8
Approach LOS					C

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	50.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	116	94	94	66	373	223
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	126	102	102	72	405	242
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						14
Median type					TWLTL	
Median storage veh)					5	
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			126		402	126
vC1, stage 1 conf vol					126	
vC2, stage 2 conf vol					276	
vCu, unblocked vol			126		402	126
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)			2.2		3.5	3.3
p0 queue free %			93		43	74
cM capacity (veh/h)			1460		715	924

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	126	102	102	72	648
Volume Left	0	0	102	0	405
Volume Right	0	102	0	0	242
cSH	1700	1700	1460	1700	1142
Volume to Capacity	0.07	0.06	0.07	0.04	0.57
Queue Length 95th (ft)	0	0	6	0	93
Control Delay (s)	0.0	0.0	7.7	0.0	14.1
Lane LOS			A		B
Approach Delay (s)	0.0		4.5		14.1
Approach LOS					B

Intersection Summary			
Average Delay	9.5		
Intersection Capacity Utilization	39.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.43	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	793	1863	1863	1583
Volume (vph)	57	79	77	511	391	86
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	62	86	84	555	425	93
RTOR Reduction (vph)	0	76	0	0	0	36
Lane Group Flow (vph)	62	10	84	555	425	57
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	6.2	6.2	41.6	41.6	34.4	34.4
Effective Green, g (s)	6.2	6.2	41.6	41.6	34.4	34.4
Actuated g/C Ratio	0.11	0.11	0.75	0.75	0.62	0.62
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	197	176	647	1389	1149	976
v/s Ratio Prot	c0.04		0.01	c0.30	0.23	
v/s Ratio Perm		0.01	0.09			0.04
v/c Ratio	0.31	0.05	0.13	0.40	0.37	0.06
Uniform Delay, d1	22.8	22.2	2.3	2.6	5.3	4.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	0.1	0.1	0.9	0.9	0.1
Delay (s)	23.8	22.3	2.4	3.4	6.2	4.4
Level of Service	C	C	A	A	A	A
Approach Delay (s)	22.9			3.3	5.9	
Approach LOS	C			A	A	

Intersection Summary			
HCM Average Control Delay	6.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	55.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
8: Kealakehe Parkway & Queen Kaahumanu Highway 6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1795	1583		1782	1583	1770	1863	1583	1770	1863	1583
Flt Permitted		0.48	1.00		0.68	1.00	0.07	1.00	1.00	0.14	1.00	1.00
Satd. Flow (perm)		896	1583		1275	1583	135	1863	1583	258	1863	1583
Volume (vph)	59	19	71	210	20	54	60	851	156	52	991	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	228	22	59	65	925	170	57	1077	48
RTOR Reduction (vph)	0	0	61	0	0	47	0	0	64	0	0	18
Lane Group Flow (vph)	0	85	16	0	250	12	65	925	106	57	1077	30
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		18.5	18.5		18.5	18.5	58.2	55.1	55.1	58.2	55.1	55.1
Effective Green, g (s)		18.5	18.5		18.5	18.5	58.2	55.1	55.1	58.2	55.1	55.1
Actuated g/C Ratio		0.21	0.21		0.21	0.21	0.66	0.62	0.62	0.66	0.62	0.62
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		187	330		266	330	146	1157	983	222	1157	983
v/s Ratio Prot							c0.02	0.50		0.01	c0.58	
v/s Ratio Perm		0.09	0.01		c0.20	0.01	0.28		0.07	0.16		0.02
v/c Ratio		0.45	0.05		0.94	0.04	0.45	0.80	0.11	0.26	0.93	0.03
Uniform Delay, d1		30.7	28.1		34.6	28.0	18.4	12.6	6.8	11.6	15.1	6.5
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		1.8	0.1		38.7	0.0	2.2	5.8	0.2	0.6	14.3	0.1
Delay (s)		32.4	28.1		73.2	28.0	20.6	18.5	7.0	12.2	29.4	6.5
Level of Service		C	C		E	C	C	B	A	B	C	A
Approach Delay (s)		30.4			64.6			16.9			27.7	
Approach LOS		C			E			B			C	

Intersection Summary			
HCM Average Control Delay	27.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	88.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.13	1.00
Satd. Flow (perm)	1770	1583	1863	1583	241	1863
Volume (vph)	480	244	778	102	33	733
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	265	846	111	36	797
RTOR Reduction (vph)	0	88	0	50	0	0
Lane Group Flow (vph)	522	177	846	61	36	797
Turn Type		Perm		Perm	Perm	
Protected Phases	8		2			6
Permitted Phases		8		2	6	
Actuated Green, G (s)	22.8	22.8	37.1	37.1	37.1	37.1
Effective Green, g (s)	22.8	22.8	37.1	37.1	37.1	37.1
Actuated g/C Ratio	0.34	0.34	0.55	0.55	0.55	0.55
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	594	532	1018	865	132	1018
v/s Ratio Prot	c0.29		c0.45			0.43
v/s Ratio Perm		0.11		0.04	0.15	
v/c Ratio	0.88	0.33	0.83	0.07	0.27	0.78
Uniform Delay, d1	21.2	16.9	12.8	7.3	8.2	12.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	13.9	0.4	7.9	0.2	5.0	6.0
Delay (s)	35.1	17.2	20.7	7.4	13.2	18.2
Level of Service	D	B	C	A	B	B
Approach Delay (s)	29.1		19.1			18.0
Approach LOS	C		B			B

Intersection Summary			
HCM Average Control Delay	21.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	67.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Hulikoa Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	128	119	790	202	97	1018
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	139	129	859	220	105	1107
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2176	859			859	
vC1, stage 1 conf vol	859					
vC2, stage 2 conf vol	1317					
vCu, unblocked vol	2176	859			859	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	35	64			87	
cM capacity (veh/h)	214	356			782	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	268	859	220	105	1107
Volume Left	139	0	0	105	0
Volume Right	129	0	220	0	0
cSH	414	1700	1700	782	1700
Volume to Capacity	0.65	0.51	0.13	0.13	0.65
Queue Length 95th (ft)	111	0	0	12	0
Control Delay (s)	35.0	0.0	0.0	10.3	0.0
Lane LOS	E			B	
Approach Delay (s)	35.0	0.0		0.9	
Approach LOS	E				

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	67.3%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.97	1.00	0.96	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1536	1863	1525	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.13	1.00
Satd. Flow (perm)	1770	1536	1863	1525	244	1863
Volume (vph)	271	261	670	416	250	977
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	295	284	728	452	272	1062
RTOR Reduction (vph)	0	224	0	236	0	0
Lane Group Flow (vph)	295	60	728	216	272	1062
Confl. Peds. (#/hr)		14		8	8	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	14.5	14.5	32.7	32.7	46.0	46.0
Effective Green, g (s)	14.5	14.5	32.7	32.7	46.0	46.0
Actuated g/C Ratio	0.21	0.21	0.48	0.48	0.67	0.67
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	375	325	889	728	371	1251
v/s Ratio Prot	c0.17		0.39		0.10	c0.57
v/s Ratio Perm		0.04		0.14	0.39	
v/c Ratio	0.79	0.18	0.82	0.30	0.73	0.85
Uniform Delay, d1	25.5	22.2	15.4	10.9	12.7	8.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	10.4	0.3	8.3	1.0	7.3	7.3
Delay (s)	35.9	22.4	23.7	11.9	20.0	15.9
Level of Service	D	C	C	B	B	B
Approach Delay (s)	29.3		19.2			16.7
Approach LOS	C		B			B

Intersection Summary			
HCM Average Control Delay	20.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	68.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	271	363	29	327	225	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	295	395	32	355	245	20
Pedestrians					2	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						6
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			691		537	297
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			691		537	297
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		46	97
cM capacity (veh/h)			898		456	699

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	295	395	150	237	264
Volume Left	0	0	32	0	245
Volume Right	0	395	0	0	20
cSH	1700	1700	898	1700	493
Volume to Capacity	0.17	0.23	0.04	0.14	0.54
Queue Length 95th (ft)	0	0	3	0	78
Control Delay (s)	0.0	0.0	2.2	0.0	20.8
Lane LOS			A		C
Approach Delay (s)	0.0		0.9		20.8
Approach LOS					C

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	120	156	169	240	0	126	0	70	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	130	170	184	261	0	137	0	76	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	261			130			759	759	130	797	759	261
vC1, stage 1 conf vol							130	130				
vC2, stage 2 conf vol							628	628				
vCu, unblocked vol	261			130			759	759	130	797	759	261
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			87			67	100	92	100	100	100
cM capacity (veh/h)	1304			1455			411	415	919	252	294	778

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	130	170	184	261	213	0
Volume Left	0	0	184	0	137	0
Volume Right	0	170	0	0	76	0
cSH	1304	1700	1455	1700	639	1700
Volume to Capacity	0.00	0.10	0.13	0.15	0.33	0.00
Queue Length 95th (ft)	0	0	11	0	36	0
Control Delay (s)	0.0	0.0	7.8	0.0	14.9	0.0
Lane LOS			A		B	A
Approach Delay (s)	0.0		3.2		14.9	0.0
Approach LOS					B	A

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	29.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	164	16	189	403	0	80	4	64	0	6	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	178	17	205	438	0	87	4	70	0	7	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	443			201			1040	1037	188	1074	1055	448
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	443			201			1040	1037	188	1074	1055	448
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			85			51	98	92	100	97	100
cM capacity (veh/h)	1112			1366			177	195	847	155	190	606

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	0	178	17	205	438	0	87	74	0	7
Volume Left	0	0	0	205	0	0	87	0	0	0
Volume Right	0	0	17	0	0	0	0	70	0	0
cSH	1700	1700	1700	1366	1700	1700	177	899	1700	70
Volume to Capacity	0.00	0.10	0.01	0.15	0.26	0.00	0.49	0.08	0.00	0.09
Queue Length 95th (ft)	0	0	0	13	0	0	60	7	0	7
Control Delay (s)	0.0	0.0	0.0	8.1	0.0	0.0	43.6	10.5	0.0	61.6
Lane LOS				A			E	B	A	F
Approach Delay (s)	0.0			2.6			28.4		61.6	
Approach LOS							D		F	

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.06	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	105	1863	1863	1583
Volume (vph)	113	102	142	338	1167	254
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	123	111	154	367	1268	276
RTOR Reduction (vph)	0	97	0	0	0	36
Lane Group Flow (vph)	123	14	154	367	1268	240
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	11.7	11.7	76.1	76.1	67.1	67.1
Effective Green, g (s)	11.7	11.7	76.1	76.1	67.1	67.1
Actuated g/C Ratio	0.12	0.12	0.79	0.79	0.70	0.70
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	216	193	170	1480	1305	1109
v/s Ratio Prot	c0.07		c0.05	0.20	c0.68	
v/s Ratio Perm		0.01	0.67			0.15
v/c Ratio	0.57	0.07	0.91	0.25	0.97	0.22
Uniform Delay, d1	39.7	37.2	33.3	2.5	13.5	5.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.4	0.2	42.7	0.4	19.0	0.4
Delay (s)	43.1	37.4	75.9	2.9	32.5	5.5
Level of Service	D	D	E	A	C	A
Approach Delay (s)	40.4			24.5	27.6	
Approach LOS	D			C	C	

Intersection Summary			
HCM Average Control Delay	28.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	95.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1800	1583		1780	1583	1770	1863	1549	1770	1863	1549
Flt Permitted		0.66	1.00		0.72	1.00	0.18	1.00	1.00	0.07	1.00	1.00
Satd. Flow (perm)		1235	1583		1343	1583	341	1863	1549	123	1863	1549
Volume (vph)	17	7	24	265	18	166	68	964	416	240	820	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	288	20	180	74	1048	452	261	891	52
RTOR Reduction (vph)	0	0	20	0	0	106	0	0	197	0	0	19
Lane Group Flow (vph)	0	26	6	0	308	74	74	1048	255	261	891	33
Confl. Peds. (#/hr)							2		2	2		2
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		22.0	22.0		22.0	22.0	60.0	56.8	56.8	70.8	63.6	63.6
Effective Green, g (s)		22.0	22.0		22.0	22.0	60.0	56.8	56.8	70.8	63.6	63.6
Actuated g/C Ratio		0.22	0.22		0.22	0.22	0.60	0.56	0.56	0.70	0.63	0.63
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		270	345		293	345	248	1050	873	250	1175	977
v/s Ratio Prot							0.01	0.56		c0.10	0.48	
v/s Ratio Perm		0.02	0.00		c0.23	0.05	0.17		0.16	c0.63		0.02
v/c Ratio		0.10	0.02		1.05	0.22	0.30	1.00	0.29	1.04	0.76	0.03
Uniform Delay, d1		31.5	30.9		39.4	32.3	12.3	21.9	11.5	47.6	13.2	7.0
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.2	0.0		66.6	0.3	0.7	27.3	0.8	68.9	4.6	0.1
Delay (s)		31.6	30.9		106.0	32.6	13.0	49.3	12.3	116.5	17.8	7.1
Level of Service		C	C		F	C	B	D	B	F	B	A
Approach Delay (s)		31.3			79.0			37.0			38.7	
Approach LOS		C			E			D			D	

Intersection Summary			
HCM Average Control Delay	43.7	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	100.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	190	409	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	207	445	0	0	0
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	450				661	455
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	450				661	455
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1106				424	601

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	0	207	445	0	0
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.12	0.26	0.00	0.00
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					A
Approach Delay (s)	0.0		0.0		0.0
Approach LOS					A

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	33.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	164	27	80	403	5	16
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	178	29	87	438	5	17
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			213		800	188
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			213		800	188
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		98	98
cM capacity (veh/h)			1352		329	847

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	178	29	87	438	23
Volume Left	0	0	87	0	5
Volume Right	0	29	0	0	17
cSH	1700	1700	1352	1700	1111
Volume to Capacity	0.10	0.02	0.06	0.26	0.02
Queue Length 95th (ft)	0	0	5	0	2
Control Delay (s)	0.0	0.0	7.8	0.0	11.0
Lane LOS			A		B
Approach Delay (s)	0.0		1.3		11.0
Approach LOS					B

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	32.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	227	592	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	247	643	0
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	900	653	648			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	900	653	648			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	306	463	933			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	0	0	0	247	643	0
Volume Left	0	0	0	0	0	0
Volume Right	0	0	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.00	0.00	0.15	0.38	0.00
Queue Length 95th (ft)	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A	A				
Approach Delay (s)	0.0		0.0		0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	227	592	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	247	643	0
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	900	653	648			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	900	653	648			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	306	463	933			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	0	0	0	247	643	0
Volume Left	0	0	0	0	0	0
Volume Right	0	0	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.00	0.00	0.15	0.38	0.00
Queue Length 95th (ft)	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A	A				
Approach Delay (s)	0.0		0.0		0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
13: Hina Lani Street & Project Roadway

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	227	0	0	592	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	247	0	0	643	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	648			252			900	900	257	900	900	653
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	648			252			900	900	257	900	900	653
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	933			1308			256	276	775	256	276	463

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	0	247	0	0	643	0	0	0	0	0
Volume Left	0	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	0	0	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.15	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS							A	A	A	A
Approach Delay (s)	0.0			0.0			0.0		0.0	
Approach LOS							A		A	

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	1770	1583	1863	1583	128	1863
Volume (vph)	180	84	1022	380	226	1012
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	91	1111	413	246	1100
RTOR Reduction (vph)	0	77	0	158	0	0
Lane Group Flow (vph)	196	14	1111	255	246	1100
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	13.6	13.6	54.1	54.1	66.1	66.1
Effective Green, g (s)	13.6	13.6	54.1	54.1	66.1	66.1
Actuated g/C Ratio	0.16	0.16	0.62	0.62	0.75	0.75
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	274	245	1149	977	246	1404
v/s Ratio Prot	c0.11		0.60		c0.09	0.59
v/s Ratio Perm		0.01		0.16	c0.66	
v/c Ratio	0.72	0.06	0.97	0.26	1.00	0.78
Uniform Delay, d1	35.2	31.6	16.0	7.7	30.3	6.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.6	0.1	19.7	0.6	57.4	4.4
Delay (s)	43.8	31.7	35.7	8.3	87.7	10.9
Level of Service	D	C	D	A	F	B
Approach Delay (s)	39.9		28.2			25.0
Approach LOS	D		C			C

Intersection Summary			
HCM Average Control Delay	27.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	87.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	172	102	1227	104	70	1267
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	187	111	1334	113	76	1377
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2863	1334			1334	
vC1, stage 1 conf vol	1334					
vC2, stage 2 conf vol	1529					
vCu, unblocked vol	2863	1334			1334	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	41			85	
cM capacity (veh/h)	161	188			517	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	298	1334	113	76	1377
Volume Left	187	0	0	76	0
Volume Right	111	0	113	0	0
cSH	256	1700	1700	517	1700
Volume to Capacity	1.16	0.78	0.07	0.15	0.81
Queue Length 95th (ft)	337	0	0	13	0
Control Delay (s)	129.6	0.0	0.0	13.2	0.0
Lane LOS	F			B	
Approach Delay (s)	129.6	0.0		0.7	
Approach LOS	F				

Intersection Summary			
Average Delay	12.4		
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.94	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1495	1863	1546	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	1770	1495	1863	1546	113	1863
Volume (vph)	527	373	1033	590	283	1063
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	573	405	1123	641	308	1155
RTOR Reduction (vph)	0	173	0	310	0	0
Lane Group Flow (vph)	573	232	1123	331	308	1155
Confl. Peds. (#/hr)		20		1	1	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	33.0	33.0	62.0	62.0	79.0	79.0
Effective Green, g (s)	33.0	33.0	62.0	62.0	79.0	79.0
Actuated g/C Ratio	0.28	0.28	0.52	0.52	0.66	0.66
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	487	411	963	799	254	1226
v/s Ratio Prot	c0.32		0.60		c0.13	0.62
v/s Ratio Perm		0.16		0.21	c0.67	
v/c Ratio	1.18	0.57	1.17	0.41	1.21	0.94
Uniform Delay, d1	43.5	37.3	29.0	17.8	55.7	18.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	99.2	1.8	86.2	1.6	126.3	15.1
Delay (s)	142.7	39.1	115.2	19.4	182.0	33.6
Level of Service	F	D	F	B	F	C
Approach Delay (s)	99.8		80.4			64.8
Approach LOS	F		F			E

Intersection Summary			
HCM Average Control Delay	79.5	HCM Level of Service	E
HCM Volume to Capacity ratio	1.19		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	109.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	334	489	17	612	200	74
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	363	532	18	665	217	80
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						6
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			899		737	367
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			899		737	367
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		37	87
cM capacity (veh/h)			749		344	628

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	363	532	240	443	298
Volume Left	0	0	18	0	217
Volume Right	0	532	0	0	80
cSH	1700	1700	749	1700	471
Volume to Capacity	0.21	0.31	0.02	0.26	0.63
Queue Length 95th (ft)	0	0	2	0	107
Control Delay (s)	0.0	0.0	1.0	0.0	26.3
Lane LOS			A		D
Approach Delay (s)	0.0		0.4		26.3
Approach LOS					D

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	249	111	118	167	0	438	0	293	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	271	121	128	182	0	476	0	318	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	182			271			709	709	271	868	709	182
vC1, stage 1 conf vol							271	271				
vC2, stage 2 conf vol							438	438				
vCu, unblocked vol	182			271			709	709	271	868	709	182
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			90			11	100	59	100	100	100
cM capacity (veh/h)	1394			1293			534	517	768	148	324	861

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	271	121	128	182	795	0
Volume Left	0	0	128	0	476	0
Volume Right	0	121	0	0	318	0
cSH	1394	1700	1293	1700	891	1700
Volume to Capacity	0.00	0.07	0.10	0.11	0.89	0.00
Queue Length 95th (ft)	0	0	8	0	307	0
Control Delay (s)	0.0	0.0	8.1	0.0	32.1	0.0
Lane LOS			A		D	A
Approach Delay (s)	0.0		3.4		32.1	0.0
Approach LOS					D	A

Intersection Summary			
Average Delay	17.7		
Intersection Capacity Utilization	56.2%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keahokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	535	78	180	260	0	21	3	282	0	4	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	582	85	196	283	0	23	3	307	0	4	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	288			671			1268	1265	592	1420	1350	293
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	288			671			1268	1265	592	1420	1350	293
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			79			80	98	39	100	96	100
cM capacity (veh/h)	1269			915			117	132	502	36	117	740

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	0	582	85	196	283	0	23	310	0	4
Volume Left	0	0	0	196	0	0	23	0	0	0
Volume Right	0	0	85	0	0	0	0	307	0	0
cSH	1700	1700	1700	915	1700	1700	117	508	1700	9
Volume to Capacity	0.00	0.34	0.05	0.21	0.17	0.00	0.20	0.61	0.00	0.48
Queue Length 95th (ft)	0	0	0	20	0	0	17	101	0	25
Control Delay (s)	0.0	0.0	0.0	10.0	0.0	0.0	43.3	22.9	0.0	604.1
Lane LOS				A			E	C	A	F
Approach Delay (s)	0.0			4.1			24.3		604.1	
Approach LOS							C		F	

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
7: Hina Lani Street & Mamalahoa Highway

6/24/2011

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.26	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	485	1863	1863	1583
Volume (vph)	372	238	102	666	495	208
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	404	259	111	724	538	226
RTOR Reduction (vph)	0	186	0	0	0	117
Lane Group Flow (vph)	404	73	111	724	538	109
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	16.6	16.6	33.9	33.9	26.8	26.8
Effective Green, g (s)	16.6	16.6	33.9	33.9	26.8	26.8
Actuated g/C Ratio	0.28	0.28	0.58	0.58	0.46	0.46
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	502	449	349	1080	853	725
v/s Ratio Prot	c0.23		0.02	c0.39	0.29	
v/s Ratio Perm		0.05	0.17			0.07
v/c Ratio	0.80	0.16	0.32	0.67	0.63	0.15
Uniform Delay, d1	19.4	15.7	7.3	8.5	12.1	9.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.1	0.2	0.5	3.3	3.5	0.4
Delay (s)	28.6	15.9	7.8	11.8	15.6	9.7
Level of Service	C	B	A	B	B	A
Approach Delay (s)	23.6			11.3	13.8	
Approach LOS	C			B	B	

Intersection Summary			
HCM Average Control Delay	15.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	58.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1795	1583		1778	1583	1770	1863	1583	1770	1863	1583
Flt Permitted		0.23	1.00		0.66	1.00	0.05	1.00	1.00	0.05	1.00	1.00
Satd. Flow (perm)		426	1583		1222	1583	88	1863	1583	85	1863	1583
Volume (vph)	59	19	71	387	20	192	60	1199	257	143	1457	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	421	22	209	65	1303	279	155	1584	48
RTOR Reduction (vph)	0	0	56	0	0	61	0	0	111	0	0	17
Lane Group Flow (vph)	0	85	21	0	443	148	65	1303	168	155	1584	31
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		38.0	38.0		38.0	38.0	88.0	84.8	84.8	93.6	87.6	87.6
Effective Green, g (s)		38.0	38.0		38.0	38.0	88.0	84.8	84.8	93.6	87.6	87.6
Actuated g/C Ratio		0.27	0.27		0.27	0.27	0.62	0.60	0.60	0.66	0.62	0.62
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		115	427		330	427	93	1122	953	128	1159	985
v/s Ratio Prot							0.02	0.70		c0.05	c0.85	
v/s Ratio Perm		0.20	0.01		c0.36	0.09	0.42		0.11	0.75		0.02
v/c Ratio		0.74	0.05		1.34	0.35	0.70	1.16	0.18	1.21	1.37	0.03
Uniform Delay, d1		46.9	38.0		51.4	41.4	69.8	28.0	12.5	69.6	26.6	10.2
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		21.8	0.0		173.1	0.5	20.5	82.7	0.4	147.0	170.6	0.1
Delay (s)		68.7	38.1		224.5	41.9	90.3	110.7	12.9	216.6	197.2	10.3
Level of Service		E	D		F	D	F	F	B	F	F	B
Approach Delay (s)		54.1			166.0			93.3			193.9	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	145.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.38		
Actuated Cycle Length (s)	140.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	119.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	542	286	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	589	311	0	0	0
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	316				910	321
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	316				910	321
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	100
cM capacity (veh/h)	1239				302	714

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	0	589	311	0	0
Volume Left	0	0	0	0	0
Volume Right	0	0	0	0	0
cSH	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.35	0.18	0.00	0.00
Queue Length 95th (ft)	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0
Lane LOS					A
Approach Delay (s)	0.0		0.0		0.0
Approach LOS					A

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	40.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	535	7	21	260	26	78
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	582	8	23	283	28	85
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			594		920	592
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			594		920	592
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		90	83
cM capacity (veh/h)			978		291	502

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	582	8	23	283	113
Volume Left	0	0	23	0	28
Volume Right	0	8	0	0	85
cSH	1700	1700	978	1700	670
Volume to Capacity	0.34	0.00	0.02	0.17	0.17
Queue Length 95th (ft)	0	0	2	0	15
Control Delay (s)	0.0	0.0	8.8	0.0	14.9
Lane LOS			A		B
Approach Delay (s)	0.0		0.7		14.9
Approach LOS					B

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	41.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	818	440	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	889	478	0
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1377	488	483			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1377	488	483			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	158	575	1075			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	0	0	0	889	478	0
Volume Left	0	0	0	0	0	0
Volume Right	0	0	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.00	0.00	0.52	0.28	0.00
Queue Length 95th (ft)	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A	A				
Approach Delay (s)	0.0		0.0		0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	818	440	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	889	478	0
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1377	488	483			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1377	488	483			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	158	575	1075			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	0	0	0	889	478	0
Volume Left	0	0	0	0	0	0
Volume Right	0	0	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.00	0.00	0.52	0.28	0.00
Queue Length 95th (ft)	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A	A				
Approach Delay (s)	0.0		0.0		0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	818	0	0	440	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	889	0	0	478	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	483			894			1377	1377	899	1377	1377	488
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	483			894			1377	1377	899	1377	1377	488
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	1075			756			120	144	335	120	144	575

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	0	889	0	0	478	0	0	0	0	0
Volume Left	0	0	0	0	0	0	0	0	0	0
Volume Right	0	0	0	0	0	0	0	0	0	0
cSH	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.52	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00
Queue Length 95th (ft)	0	0	0	0	0	0	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane LOS							A	A	A	A
Approach Delay (s)	0.0			0.0			0.0		0.0	
Approach LOS							A		A	

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix H - Intersection Operations Analysis Worksheets for 2015 With Project Phase I Conditions, with Existing Geometry

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.05	1.00
Satd. Flow (perm)	1770	1583	1863	1583	94	1863
Volume (vph)	480	244	1077	102	33	1212
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	265	1171	111	36	1317
RTOR Reduction (vph)	0	75	0	38	0	0
Lane Group Flow (vph)	522	190	1171	73	36	1317
Turn Type		Perm		Perm	Perm	
Protected Phases	8		2			6
Permitted Phases		8		2	6	
Actuated Green, G (s)	33.0	33.0	79.0	79.0	79.0	79.0
Effective Green, g (s)	33.0	33.0	79.0	79.0	79.0	79.0
Actuated g/C Ratio	0.28	0.28	0.66	0.66	0.66	0.66
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	487	435	1226	1042	62	1226
v/s Ratio Prot	c0.29		0.63			c0.71
v/s Ratio Perm		0.12		0.05	0.38	
v/c Ratio	1.07	0.44	0.96	0.07	0.58	1.07
Uniform Delay, d1	43.5	35.9	18.9	7.3	11.3	20.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	61.4	0.7	17.0	0.1	34.1	48.1
Delay (s)	104.9	36.6	35.8	7.5	45.4	68.6
Level of Service	F	D	D	A	D	E
Approach Delay (s)	81.9		33.4			68.0
Approach LOS	F		C			E

Intersection Summary			
HCM Average Control Delay	58.2	HCM Level of Service	E
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	97.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Hulikoa Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	162	234	974	245	281	1312
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	176	254	1059	266	305	1426
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3096	1059			1059	
vC1, stage 1 conf vol	1059					
vC2, stage 2 conf vol	2037					
vCu, unblocked vol	3096	1059			1059	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	7			54	
cM capacity (veh/h)	59	273			658	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	430	1059	266	305	1426
Volume Left	176	0	0	305	0
Volume Right	254	0	266	0	0
cSH	123	1700	1700	658	1700
Volume to Capacity	3.51	0.62	0.16	0.46	0.84
Queue Length 95th (ft)	Err	0	0	62	0
Control Delay (s)	Err	0.0	0.0	15.1	0.0
Lane LOS	F			C	
Approach Delay (s)	Err	0.0		2.7	
Approach LOS	F				

Intersection Summary			
Average Delay	1235.6		
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
3: Hina Lani Street & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.96	1.00	0.95	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1520	1863	1509	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.09	1.00
Satd. Flow (perm)	1770	1520	1863	1509	173	1863
Volume (vph)	651	445	713	1035	544	1011
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	708	484	775	1125	591	1099
RTOR Reduction (vph)	0	246	0	431	0	0
Lane Group Flow (vph)	708	238	775	694	591	1099
Confl. Peds. (#/hr)		14		8	8	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	35.0	35.0	39.0	39.0	67.0	67.0
Effective Green, g (s)	35.0	35.0	39.0	39.0	67.0	67.0
Actuated g/C Ratio	0.32	0.32	0.35	0.35	0.61	0.61
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	563	484	661	535	454	1135
v/s Ratio Prot	c0.40		0.42		c0.28	0.59
v/s Ratio Perm		0.16		0.46	c0.51	
v/c Ratio	1.26	0.49	1.17	1.30	1.30	0.97
Uniform Delay, d1	37.5	30.3	35.5	35.5	45.2	20.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	129.8	0.8	93.1	147.5	151.2	20.1
Delay (s)	167.3	31.1	128.6	183.0	196.4	40.6
Level of Service	F	C	F	F	F	D
Approach Delay (s)	112.0		160.8			95.1
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	125.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.27		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	113.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1184	363	29	1116	0	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1287	395	32	1213	0	20
Pedestrians					2	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			1684		1959	1289
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1684		1959	1289
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		100	87
cM capacity (veh/h)			375		51	154

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1287	395	436	809	20
Volume Left	0	0	32	0	0
Volume Right	0	395	0	0	20
cSH	1700	1700	375	1700	154
Volume to Capacity	0.76	0.23	0.08	0.48	0.13
Queue Length 95th (ft)	0	0	7	0	11
Control Delay (s)	0.0	0.0	2.7	0.0	31.7
Lane LOS			A		D
Approach Delay (s)	0.0		0.9		31.7
Approach LOS					D

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	346	687	156	169	692	126	214	10	70	87	10	249
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	376	747	170	184	752	137	233	11	76	95	11	271
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	889			747			2759	2755	747	2730	2687	821
vC1, stage 1 conf vol							1499	1499				
vC2, stage 2 conf vol							1260	1257				
vCu, unblocked vol	889			747			2759	2755	747	2730	2687	821
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	51			79			0	0	82	0	0	28
cM capacity (veh/h)	762			862			0	8	413	0	9	375

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	1123	170	184	889	320	376
Volume Left	376	0	184	0	233	95
Volume Right	0	170	0	137	76	271
cSH	762	1700	862	1700	0	0
Volume to Capacity	0.49	0.10	0.21	0.52	Err	331.11
Queue Length 95th (ft)	69	0	20	0	Err	Err
Control Delay (s)	13.1	0.0	10.3	0.0	Err	Err
Lane LOS	B		B		F	F
Approach Delay (s)	11.4		1.8		Err	Err
Approach LOS					F	F

Intersection Summary			
Average Delay	2277.9		
Intersection Capacity Utilization	128.4%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	352	196	71	189	490	300	148	248	64	209	147	168
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	383	213	77	205	533	326	161	270	70	227	160	183
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	864			295			2103	2258	223	2101	2009	543
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	864			295			2103	2258	223	2101	2009	543
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	51			84			0	0	91	0	0	66
cM capacity (veh/h)	776			1261			0	17	810	0	25	535

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	383	213	77	205	533	326	161	339	227	342
Volume Left	383	0	0	205	0	0	161	0	227	0
Volume Right	0	0	77	0	0	326	0	70	0	183
cSH	776	1700	1700	1261	1700	1700	0	22	0	51
Volume to Capacity	0.49	0.13	0.05	0.16	0.31	0.19	Err	15.66	Err	6.73
Queue Length 95th (ft)	69	0	0	15	0	0	Err	Err	Err	Err
Control Delay (s)	14.1	0.0	0.0	8.4	0.0	0.0	Err	Err	Err	Err
Lane LOS	B			A			F	F	F	F
Approach Delay (s)	8.0			1.6			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.04	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	82	1863	1863	1583
Volume (vph)	228	228	344	338	1167	437
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	248	248	374	367	1268	475
RTOR Reduction (vph)	0	216	0	0	0	48
Lane Group Flow (vph)	248	32	374	367	1268	427
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	18.0	18.0	114.0	114.0	87.0	87.0
Effective Green, g (s)	18.0	18.0	114.0	114.0	87.0	87.0
Actuated g/C Ratio	0.13	0.13	0.81	0.81	0.62	0.62
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	228	204	344	1517	1158	984
v/s Ratio Prot	c0.14		c0.18	0.20	0.68	
v/s Ratio Perm		0.02	c0.71			0.27
v/c Ratio	1.09	0.16	1.09	0.24	1.09	0.43
Uniform Delay, d1	61.0	54.2	60.7	3.0	26.5	13.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	85.0	0.4	73.9	0.4	56.3	1.4
Delay (s)	146.0	54.6	134.6	3.4	82.8	15.1
Level of Service	F	D	F	A	F	B
Approach Delay (s)	100.3			69.6	64.4	
Approach LOS	F			E	E	

Intersection Summary			
HCM Average Control Delay	71.7	HCM Level of Service	E
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	103.1%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1800	1583		1778	1583	1770	1863	1549	1770	1863	1549
Flt Permitted		0.41	1.00		0.72	1.00	0.04	1.00	1.00	0.04	1.00	1.00
Satd. Flow (perm)		770	1583		1337	1583	79	1863	1549	76	1863	1549
Volume (vph)	17	7	24	357	18	166	68	1626	563	240	1234	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	388	20	180	74	1767	612	261	1341	52
RTOR Reduction (vph)	0	0	20	0	0	53	0	0	191	0	0	17
Lane Group Flow (vph)	0	26	6	0	408	127	74	1767	421	261	1341	35
Confl. Peds. (#/hr)							2		2	2		2
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		33.0	33.0		33.0	33.0	98.0	94.0	94.0	109.0	101.0	101.0
Effective Green, g (s)		33.0	33.0		33.0	33.0	98.0	94.0	94.0	109.0	101.0	101.0
Actuated g/C Ratio		0.22	0.22		0.22	0.22	0.65	0.63	0.63	0.73	0.67	0.67
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		169	348		294	348	97	1167	971	179	1254	1043
v/s Ratio Prot							0.02	c0.95		c0.11	0.72	
v/s Ratio Perm		0.03	0.00		c0.31	0.08	0.48		0.27	0.95		0.02
v/c Ratio		0.15	0.02		1.39	0.36	0.76	1.51	0.43	1.46	1.07	0.03
Uniform Delay, d1		47.2	45.8		58.5	49.6	74.2	28.0	14.4	71.7	24.5	8.2
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.4	0.0		194.2	0.7	29.2	235.8	1.4	234.3	46.2	0.1
Delay (s)		47.7	45.8		252.7	50.3	103.4	263.8	15.8	306.0	70.7	8.2
Level of Service		D	D		F	D	F	F	B	F	E	A
Approach Delay (s)		46.7			190.7			197.1			105.8	
Approach LOS		D			F			F			F	

Intersection Summary				
HCM Average Control Delay	162.9	HCM Level of Service	F	
HCM Volume to Capacity ratio	1.48			
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	136.3%	ICU Level of Service	H	
Analysis Period (min)	15			

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	215	629	839	29	0	147
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	234	684	912	32	0	160
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	948				2073	922
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	948				2073	922
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	68				100	51
cM capacity (veh/h)	721				40	325

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	234	684	912	32	160
Volume Left	234	0	0	0	0
Volume Right	0	0	0	32	160
cSH	721	1700	1700	1700	325
Volume to Capacity	0.32	0.40	0.54	0.02	0.49
Queue Length 95th (ft)	35	0	0	0	65
Control Delay (s)	12.4	0.0	0.0	0.0	26.4
Lane LOS	B				D
Approach Delay (s)	3.2		0.0		26.4
Approach LOS					D

Intersection Summary			
Average Delay	3.5		
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	602	27	80	726	142	16
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	654	29	87	789	154	17
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			689		1627	664
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			689		1627	664
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			90		0	96
cM capacity (veh/h)			902		101	457

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	654	29	87	789	172
Volume Left	0	0	87	0	154
Volume Right	0	29	0	0	17
cSH	1700	1700	902	1700	110
Volume to Capacity	0.38	0.02	0.10	0.46	1.56
Queue Length 95th (ft)	0	0	8	0	319
Control Delay (s)	0.0	0.0	9.4	0.0	362.3
Lane LOS			A		F
Approach Delay (s)	0.0		0.9		362.3
Approach LOS					F

Intersection Summary			
Average Delay	36.4		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	468	978	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	509	1063	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1582	1073	1068			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1582	1073	1068			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	119	266	652			

Direction, Lane #	NE 1	SW 1
Volume Total	509	1063
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.30	0.63
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations				↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	468	978	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	509	1063	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1582	1073	1068			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1582	1073	1068			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	119	266	652			

Direction, Lane #	NE 1	SW 1
Volume Total	509	1063
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.30	0.63
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑							
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	468	0	0	978	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	509	0	0	1063	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1068			514			1582	1582	519	1582	1582	1073
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1068			514			1582	1582	519	1582	1582	1073
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	652			1052			88	109	555	88	109	266

Direction, Lane #	EB 1	WB 1
Volume Total	509	1063
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.30	0.63
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.04	1.00
Satd. Flow (perm)	1770	1583	1863	1583	67	1863
Volume (vph)	180	84	1454	380	226	1362
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	91	1580	413	246	1480
RTOR Reduction (vph)	0	81	0	116	0	0
Lane Group Flow (vph)	196	10	1580	297	246	1480
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	16.0	16.0	108.0	108.0	126.0	126.0
Effective Green, g (s)	16.0	16.0	108.0	108.0	126.0	126.0
Actuated g/C Ratio	0.11	0.11	0.72	0.72	0.84	0.84
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	189	169	1341	1140	215	1565
v/s Ratio Prot	c0.11		c0.85		c0.11	0.79
v/s Ratio Perm		0.01		0.19	0.86	
v/c Ratio	1.04	0.06	1.18	0.26	1.14	0.95
Uniform Delay, d1	67.0	60.2	21.0	7.2	70.2	9.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	75.5	0.1	88.3	0.6	105.7	13.1
Delay (s)	142.5	60.4	109.3	7.8	175.9	22.4
Level of Service	F	E	F	A	F	C
Approach Delay (s)	116.5		88.2			44.3
Approach LOS	F		F			D

Intersection Summary			
HCM Average Control Delay	71.3	HCM Level of Service	E
HCM Volume to Capacity ratio	1.16		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	109.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	217	268	1493	140	205	1483
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	236	291	1623	152	223	1612
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3680	1623			1623	
vC1, stage 1 conf vol	1623					
vC2, stage 2 conf vol	2058					
vCu, unblocked vol	3680	1623			1623	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	0			44	
cM capacity (veh/h)	48	127			401	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	527	1623	152	223	1612
Volume Left	236	0	0	223	0
Volume Right	291	0	152	0	0
cSH	78	1700	1700	401	1700
Volume to Capacity	6.77	0.95	0.09	0.56	0.95
Queue Length 95th (ft)	Err	0	0	82	0
Control Delay (s)	Err	0.0	0.0	24.7	0.0
Lane LOS	F			C	
Approach Delay (s)	Err	0.0		3.0	
Approach LOS	F				

Intersection Summary			
Average Delay	1275.5		
Intersection Capacity Utilization	112.0%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.94	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1489	1863	1545	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	1770	1489	1863	1545	138	1863
Volume (vph)	1081	639	1070	1038	499	1108
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1175	695	1163	1128	542	1204
RTOR Reduction (vph)	0	180	0	496	0	0
Lane Group Flow (vph)	1175	515	1163	632	542	1204
Confl. Peds. (#/hr)		20		1	1	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	50.0	50.0	50.0	50.0	72.0	72.0
Effective Green, g (s)	50.0	50.0	50.0	50.0	72.0	72.0
Actuated g/C Ratio	0.38	0.38	0.38	0.38	0.55	0.55
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	681	573	717	594	302	1032
v/s Ratio Prot	c0.66		0.62		c0.25	0.65
v/s Ratio Perm		0.35		0.41	c0.74	
v/c Ratio	1.73	0.90	1.62	1.06	1.79	1.17
Uniform Delay, d1	40.0	37.6	40.0	40.0	58.2	29.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	332.6	16.7	286.3	55.1	370.6	85.7
Delay (s)	372.6	54.3	326.3	95.1	428.8	114.7
Level of Service	F	D	F	F	F	F
Approach Delay (s)	254.3		212.5			212.2
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	225.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.74		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	153.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	998	489	17	1631	0	74
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1085	532	18	1773	0	80
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			1620		2012	1089
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1620		2012	1089
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		100	62
cM capacity (veh/h)			397		49	210

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1085	532	609	1182	80
Volume Left	0	0	18	0	0
Volume Right	0	532	0	0	80
cSH	1700	1700	397	1700	210
Volume to Capacity	0.64	0.31	0.05	0.70	0.38
Queue Length 95th (ft)	0	0	4	0	42
Control Delay (s)	0.0	0.0	1.4	0.0	32.4
Lane LOS			A		D
Approach Delay (s)	0.0		0.5		32.4
Approach LOS					D

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Hina Lani Street & Kamanu Street

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	268	644	111	118	869	94	398	10	293	130	10	358
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	291	700	121	128	945	102	433	11	318	141	11	389
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1047			700			2684	2586	700	2699	2535	996
vC1, stage 1 conf vol							1283	1283				
vC2, stage 2 conf vol							1401	1303				
vCu, unblocked vol	1047			700			2684	2586	700	2699	2535	996
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	56			86			0	11	28	0	17	0
cM capacity (veh/h)	665			897			0	12	439	1	13	297

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	991	121	128	1047	762	541
Volume Left	291	0	128	0	433	141
Volume Right	0	121	0	102	318	389
cSH	665	1700	897	1700	0	2
Volume to Capacity	0.44	0.07	0.14	0.62	Err	235.09
Queue Length 95th (ft)	56	0	12	0	Err	Err
Control Delay (s)	11.9	0.0	9.7	0.0	Err	Err
Lane LOS	B		A		F	F
Approach Delay (s)	10.7		1.1		Err	Err
Approach LOS					F	F

Intersection Summary			
Average Delay	3633.3		
Intersection Capacity Utilization	139.4%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keahokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	223	593	150	180	332	210	79	174	282	291	215	275
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	242	645	163	196	361	228	86	189	307	316	234	299
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	594			813			2158	2120	655	2139	2055	371
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	594			813			2158	2120	655	2139	2055	371
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	75			76			0	0	34	0	0	55
cM capacity (veh/h)	978			811			0	28	462	0	31	669

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	242	645	163	196	361	228	86	496	316	533
Volume Left	242	0	0	196	0	0	86	0	316	0
Volume Right	0	0	163	0	0	228	0	307	0	299
cSH	978	1700	1700	811	1700	1700	0	68	0	68
Volume to Capacity	0.25	0.38	0.10	0.24	0.21	0.13	Err	7.25	Err	7.88
Queue Length 95th (ft)	24	0	0	24	0	0	Err	Err	Err	Err
Control Delay (s)	9.9	0.0	0.0	10.8	0.0	0.0	Err	Err	Err	Err
Lane LOS	A			B			F	F	F	F
Approach Delay (s)	2.3			2.7			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	80.4%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.15	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	275	1863	1863	1583
Volume (vph)	539	420	250	666	495	343
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	586	457	272	724	538	373
RTOR Reduction (vph)	0	253	0	0	0	177
Lane Group Flow (vph)	586	204	272	724	538	196
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	25.0	25.0	36.1	36.1	23.1	23.1
Effective Green, g (s)	25.0	25.0	36.1	36.1	23.1	23.1
Actuated g/C Ratio	0.36	0.36	0.52	0.52	0.33	0.33
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	640	573	338	973	623	529
v/s Ratio Prot	c0.33		0.10	c0.39	0.29	
v/s Ratio Perm		0.13	c0.32			0.12
v/c Ratio	0.92	0.36	0.80	0.74	0.86	0.37
Uniform Delay, d1	21.0	16.1	13.1	12.9	21.5	17.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	17.8	0.4	13.0	5.1	14.7	2.0
Delay (s)	38.8	16.5	26.1	18.0	36.3	19.5
Level of Service	D	B	C	B	D	B
Approach Delay (s)	29.1			20.3	29.4	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	26.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	69.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1795	1583		1777	1583	1770	1863	1583	1770	1863	1583
Flt Permitted		0.11	1.00		0.65	1.00	0.09	1.00	1.00	0.13	1.00	1.00
Satd. Flow (perm)		207	1583		1216	1583	170	1863	1583	251	1863	1583
Volume (vph)	59	19	71	520	20	192	60	1684	365	143	2055	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	565	22	209	65	1830	397	155	2234	48
RTOR Reduction (vph)	0	0	37	0	0	42	0	0	119	0	0	12
Lane Group Flow (vph)	0	85	40	0	587	167	65	1830	278	155	2234	36
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		44.0	44.0		44.0	44.0	94.0	90.8	90.8	95.6	91.6	91.6
Effective Green, g (s)		44.0	44.0		44.0	44.0	94.0	90.8	90.8	95.6	91.6	91.6
Actuated g/C Ratio		0.29	0.29		0.29	0.29	0.62	0.60	0.60	0.63	0.61	0.61
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		60	462		355	462	140	1122	953	199	1132	962
v/s Ratio Prot							0.01	0.98		c0.02	c1.20	
v/s Ratio Perm		0.41	0.03		c0.48	0.11	0.28		0.18	0.47		0.02
v/c Ratio		1.42	0.09		1.65	0.36	0.46	1.63	0.29	0.78	1.97	0.04
Uniform Delay, d1		53.4	38.8		53.4	42.3	11.1	30.0	14.5	12.2	29.6	11.9
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		260.8	0.1		306.4	0.5	2.4	288.0	0.8	17.3	441.3	0.1
Delay (s)		314.2	38.9		359.8	42.7	13.5	318.0	15.3	29.5	470.9	12.0
Level of Service		F	D		F	D	B	F	B	C	F	B
Approach Delay (s)		183.4			276.6			257.0			433.8	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	333.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.80		
Actuated Cycle Length (s)	150.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	158.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	172	895	895	36	0	186
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	187	973	973	39	0	202
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1017				2330	983
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1017				2330	983
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	72				100	32
cM capacity (veh/h)	679				29	299

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	187	973	973	39	202
Volume Left	187	0	0	0	0
Volume Right	0	0	0	39	202
cSH	679	1700	1700	1700	299
Volume to Capacity	0.28	0.57	0.57	0.02	0.68
Queue Length 95th (ft)	28	0	0	0	114
Control Delay (s)	12.3	0.0	0.0	0.0	38.8
Lane LOS	B				E
Approach Delay (s)	2.0		0.0		38.8
Approach LOS					E

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	888	7	21	666	266	78
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	965	8	23	724	289	85
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			978		1745	975
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			978		1745	975
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		0	72
cM capacity (veh/h)			703		91	302

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	965	8	23	724	374
Volume Left	0	0	23	0	289
Volume Right	0	8	0	0	85
cSH	1700	1700	703	1700	109
Volume to Capacity	0.57	0.00	0.03	0.43	3.44
Queue Length 95th (ft)	0	0	3	0	Err
Control Delay (s)	0.0	0.0	10.3	0.0	Err
Lane LOS			B		F
Approach Delay (s)	0.0		0.3		Err
Approach LOS					F

Intersection Summary			
Average Delay	1786.0		
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations				↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	1167	722	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	1268	785	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2063	795	790			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2063	795	790			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	60	386	830			

Direction, Lane #	NE 1	SW 1
Volume Total	1268	785
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.75	0.46
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations				↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	1167	722	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	1268	785	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2063	795	790			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2063	795	790			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	60	386	830			

Direction, Lane #	NE 1	SW 1
Volume Total	1268	785
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.75	0.46
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
13: Hina Lani Street & Project Roadway

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑							
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1167	0	0	722	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	1268	0	0	785	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	790			1273			2063	2063	1278	2063	2063	795
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	790			1273			2063	2063	1278	2063	2063	795
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	830			545			40	55	202	40	55	386

Direction, Lane #	EB 1	WB 1
Volume Total	1268	785
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.75	0.46
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.13	1.00
Satd. Flow (perm)	1770	1583	3539	1583	234	3539
Volume (vph)	480	244	1077	102	33	1212
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	265	1171	111	36	1317
RTOR Reduction (vph)	0	119	0	60	0	0
Lane Group Flow (vph)	522	146	1171	51	36	1317
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	19.8	19.8	27.9	27.9	33.5	33.5
Effective Green, g (s)	19.8	19.8	27.9	27.9	33.5	33.5
Actuated g/C Ratio	0.32	0.32	0.46	0.46	0.55	0.55
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	572	511	1611	720	168	1934
v/s Ratio Prot	c0.29		0.33		0.01	c0.37
v/s Ratio Perm		0.09		0.03	0.11	
v/c Ratio	0.91	0.29	0.73	0.07	0.21	0.68
Uniform Delay, d1	19.9	15.5	13.6	9.4	9.1	10.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	19.0	0.3	2.9	0.2	0.6	2.0
Delay (s)	38.9	15.8	16.5	9.6	9.7	12.0
Level of Service	D	B	B	A	A	B
Approach Delay (s)	31.1		15.9			11.9
Approach LOS	C		B			B

Intersection Summary			
HCM Average Control Delay	17.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	61.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.95	1.00	1.00	0.95
Frt	0.94	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3301	1441	3539	1583	1770	3539
Flt Permitted	0.97	1.00	1.00	1.00	0.17	1.00
Satd. Flow (perm)	3301	1441	3539	1583	314	3539
Volume (vph)	162	234	974	245	281	1312
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	176	254	1059	266	305	1426
RTOR Reduction (vph)	93	116	0	160	0	0
Lane Group Flow (vph)	196	25	1059	106	305	1426
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	8.9	8.9	19.7	19.7	32.7	32.7
Effective Green, g (s)	8.9	8.9	19.7	19.7	32.7	32.7
Actuated g/C Ratio	0.18	0.18	0.40	0.40	0.66	0.66
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	592	259	1406	629	471	2333
v/s Ratio Prot	c0.06		c0.30		0.12	c0.40
v/s Ratio Perm		0.02		0.07	0.31	
v/c Ratio	0.33	0.10	0.75	0.17	0.65	0.61
Uniform Delay, d1	17.8	17.0	12.9	9.7	6.6	4.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.3	0.2	2.3	0.1	3.1	0.5
Delay (s)	18.1	17.2	15.2	9.8	9.7	5.3
Level of Service	B	B	B	A	A	A
Approach Delay (s)	17.8		14.1			6.1
Approach LOS	B		B			A

Intersection Summary			
HCM Average Control Delay	10.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	49.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	59.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.95	1.00	0.97	0.95
Frpb, ped/bikes	1.00	0.98	1.00	0.99	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1558	3539	1561	3433	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3433	1558	3539	1561	3433	3539
Volume (vph)	651	445	713	1035	544	1011
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	708	484	775	1125	591	1099
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	708	484	775	1125	591	1099
Confl. Peds. (#/hr)		14		8	8	
Turn Type		Free		Free	Prot	
Protected Phases	8		2		1	6
Permitted Phases		Free		Free		
Actuated Green, G (s)	15.2	59.2	19.4	59.2	12.6	36.0
Effective Green, g (s)	15.2	59.2	19.4	59.2	12.6	36.0
Actuated g/C Ratio	0.26	1.00	0.33	1.00	0.21	0.61
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	881	1558	1160	1561	731	2152
v/s Ratio Prot	0.21		0.22		0.17	0.31
v/s Ratio Perm		0.31		c0.72		
v/c Ratio	0.80	0.31	0.67	0.72	0.81	0.51
Uniform Delay, d1	20.6	0.0	17.1	0.0	22.2	6.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.4	0.5	3.1	2.9	6.6	0.9
Delay (s)	26.0	0.5	20.2	2.9	28.7	7.5
Level of Service	C	A	C	A	C	A
Approach Delay (s)	15.6		10.0			14.9
Approach LOS	B		A			B

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	59.2	Sum of lost time (s)	0.0
Intersection Capacity Utilization	63.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1184	363	29	1116	0	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1287	395	32	1213	0	20
Pedestrians					2	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			1684		1959	645
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1684		1959	645
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		100	95
cM capacity (veh/h)			375		51	414

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1
Volume Total	643	643	395	32	607	607	20
Volume Left	0	0	0	32	0	0	0
Volume Right	0	0	395	0	0	0	20
cSH	1700	1700	1700	375	1700	1700	414
Volume to Capacity	0.38	0.38	0.23	0.08	0.36	0.36	0.05
Queue Length 95th (ft)	0	0	0	7	0	0	4
Control Delay (s)	0.0	0.0	0.0	15.5	0.0	0.0	14.1
Lane LOS				C			B
Approach Delay (s)	0.0			0.4			14.1
Approach LOS							B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.95	0.91	0.95	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.96	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1681	1621	1504	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.96	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3539	1583	1770	3539	1583	1681	1621	1504	1770	1863	1583
Volume (vph)	346	687	156	169	692	126	214	10	70	87	10	249
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	376	747	170	184	752	137	233	11	76	95	11	271
RTOR Reduction (vph)	0	0	108	0	0	66	0	0	65	0	0	0
Lane Group Flow (vph)	376	747	62	184	752	71	122	122	11	95	11	271
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Free
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	19.4	27.2	27.2	11.4	19.2	19.2	10.8	10.8	10.8	9.7	9.7	75.1
Effective Green, g (s)	19.4	27.2	27.2	11.4	19.2	19.2	10.8	10.8	10.8	9.7	9.7	75.1
Actuated g/C Ratio	0.26	0.36	0.36	0.15	0.26	0.26	0.14	0.14	0.14	0.13	0.13	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	457	1282	573	269	905	405	242	233	216	229	241	1583
v/s Ratio Prot	c0.21	0.21		0.10	c0.21		0.07	c0.08		c0.05	0.01	
v/s Ratio Perm			0.04			0.04			0.01			0.17
v/c Ratio	0.82	0.58	0.11	0.68	0.83	0.17	0.50	0.52	0.05	0.41	0.05	0.17
Uniform Delay, d1	26.2	19.4	15.9	30.1	26.4	21.8	29.7	29.8	27.7	30.1	28.6	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	11.4	0.7	0.1	7.0	6.6	0.2	1.7	2.1	0.1	1.2	0.1	0.2
Delay (s)	37.6	20.0	16.0	37.2	33.0	22.0	31.3	31.9	27.8	31.3	28.7	0.2
Level of Service	D	C	B	D	C	C	C	C	C	C	C	A
Approach Delay (s)		24.6			32.3			30.7			8.9	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	26.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	75.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	61.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1530	1770	1863	1530	1770	1863	1551	1770	1863	1551
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3539	1530	1770	1863	1530	1770	1863	1551	1770	1863	1551
Volume (vph)	352	196	71	189	490	300	148	248	64	209	147	168
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	383	213	77	205	533	326	161	270	70	227	160	183
RTOR Reduction (vph)	0	0	50	0	0	231	0	0	58	0	0	149
Lane Group Flow (vph)	383	213	27	205	533	95	161	270	12	227	160	34
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	20.0	31.4	31.4	14.6	26.0	26.0	10.5	15.3	15.3	12.0	16.8	16.8
Effective Green, g (s)	20.0	31.4	31.4	14.6	26.0	26.0	10.5	15.3	15.3	12.0	16.8	16.8
Actuated g/C Ratio	0.22	0.35	0.35	0.16	0.29	0.29	0.12	0.17	0.17	0.13	0.19	0.19
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	396	1244	538	289	542	445	208	319	266	238	350	292
v/s Ratio Prot	c0.22	0.06		0.12	c0.29		0.09	c0.14		c0.13	0.09	
v/s Ratio Perm			0.02			0.06			0.01			0.02
v/c Ratio	0.97	0.17	0.05	0.71	0.98	0.21	0.77	0.85	0.05	0.95	0.46	0.12
Uniform Delay, d1	34.3	20.0	19.1	35.3	31.4	23.9	38.2	35.9	30.9	38.4	32.2	30.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	36.3	0.1	0.0	7.7	34.2	0.2	16.3	18.3	0.1	45.2	0.9	0.2
Delay (s)	70.6	20.0	19.1	43.1	65.6	24.2	54.5	54.2	31.0	83.6	33.1	30.3
Level of Service	E	C	B	D	E	C	D	D	C	F	C	C
Approach Delay (s)		48.7			48.6			51.0			52.3	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	49.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	89.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	3539	1583
Flt Permitted	0.95	1.00	0.12	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	220	1863	3539	1583
Volume (vph)	228	228	344	338	1167	437
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	248	248	374	367	1268	475
RTOR Reduction (vph)	0	199	0	0	0	174
Lane Group Flow (vph)	248	49	374	367	1268	301
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	13.4	13.4	46.1	46.1	29.9	29.9
Effective Green, g (s)	13.4	13.4	46.1	46.1	29.9	29.9
Actuated g/C Ratio	0.20	0.20	0.68	0.68	0.44	0.44
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	351	314	430	1272	1568	701
v/s Ratio Prot	c0.14		c0.16	0.20	0.36	
v/s Ratio Perm		0.03	c0.44			0.19
v/c Ratio	0.71	0.16	0.87	0.29	0.81	0.43
Uniform Delay, d1	25.2	22.4	17.1	4.2	16.3	12.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	6.4	0.2	16.8	0.6	4.6	1.9
Delay (s)	31.6	22.6	33.9	4.8	20.9	14.8
Level of Service	C	C	C	A	C	B
Approach Delay (s)	27.1			19.5	19.3	
Approach LOS	C			B	B	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	67.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	73.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.91	
Frpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected		0.97	1.00	0.95	0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1800	1583	1681	1693	1583	1770	3539	1549	1770	5053	
Flt Permitted		0.97	1.00	0.95	0.96	1.00	0.17	1.00	1.00	0.06	1.00	
Satd. Flow (perm)		1800	1583	1681	1693	1583	315	3539	1549	116	5053	
Volume (vph)	17	7	24	357	18	166	68	1626	563	240	1234	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	388	20	180	74	1767	612	261	1341	52
RTOR Reduction (vph)	0	0	25	0	0	128	0	0	279	0	3	0
Lane Group Flow (vph)	0	26	1	199	209	52	74	1767	333	261	1390	0
Confl. Peds. (#/hr)							2		2	2		2
Turn Type	Split		Perm	Split		Perm	pm+pt		Perm	pm+pt		
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8	2		2	6		
Actuated Green, G (s)		5.4	5.4	15.7	15.7	15.7	64.8	60.1	60.1	77.2	68.5	
Effective Green, g (s)		5.4	5.4	15.7	15.7	15.7	64.8	60.1	60.1	77.2	68.5	
Actuated g/C Ratio		0.05	0.05	0.14	0.14	0.14	0.59	0.54	0.54	0.70	0.62	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		88	77	239	241	225	247	1928	844	278	3138	
v/s Ratio Prot		c0.01		0.12	c0.12		0.01	0.50		c0.11	0.28	
v/s Ratio Perm			0.00			0.03	0.16		0.22	c0.55		
v/c Ratio		0.30	0.02	0.83	0.87	0.23	0.30	0.92	0.40	0.94	0.44	
Uniform Delay, d1		50.6	49.9	46.0	46.3	42.0	9.9	22.8	14.6	36.6	10.9	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		1.9	0.1	21.3	26.3	0.5	0.7	8.4	1.4	37.4	0.5	
Delay (s)		52.5	50.0	67.3	72.6	42.5	10.6	31.2	15.9	74.0	11.4	
Level of Service		D	D	E	E	D	B	C	B	E	B	
Approach Delay (s)		51.2			61.6			26.8			21.3	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	29.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	110.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	215	629	839	29	0	147
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	234	684	912	32	0	160
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)			1250			
pX, platoon unblocked						
vC, conflicting volume	948				1731	466
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	948				1731	466
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	67				100	70
cM capacity (veh/h)	717				53	539

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	SB 1
Volume Total	234	342	342	456	456	32	160
Volume Left	234	0	0	0	0	0	0
Volume Right	0	0	0	0	0	32	160
cSH	717	1700	1700	1700	1700	1700	539
Volume to Capacity	0.33	0.20	0.20	0.27	0.27	0.02	0.30
Queue Length 95th (ft)	35	0	0	0	0	0	31
Control Delay (s)	12.4	0.0	0.0	0.0	0.0	0.0	14.5
Lane LOS	B						B
Approach Delay (s)	3.2			0.0			14.5
Approach LOS							B

Intersection Summary			
Average Delay	2.6		
Intersection Capacity Utilization	50.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EB L	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1545	1766	3539	1770	1560
Flt Permitted	1.00	1.00	0.40	1.00	0.95	1.00
Satd. Flow (perm)	3539	1545	750	3539	1770	1560
Volume (vph)	602	27	80	726	142	16
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	654	29	87	789	154	17
RTOR Reduction (vph)	0	17	0	0	0	12
Lane Group Flow (vph)	654	12	87	789	154	5
Confl. Peds. (#/hr)		5	5		5	5
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	12.4	12.4	12.4	12.4	8.7	8.7
Effective Green, g (s)	12.4	12.4	12.4	12.4	8.7	8.7
Actuated g/C Ratio	0.43	0.43	0.43	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1508	658	320	1508	529	466
v/s Ratio Prot	0.18			c0.22	c0.09	
v/s Ratio Perm		0.01	0.12			0.00
v/c Ratio	0.43	0.02	0.27	0.52	0.29	0.01
Uniform Delay, d1	5.9	4.8	5.4	6.2	7.8	7.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.0	0.5	0.3	0.3	0.0
Delay (s)	6.1	4.8	5.9	6.5	8.1	7.2
Level of Service	A	A	A	A	A	A
Approach Delay (s)	6.0			6.4	8.0	
Approach LOS	A			A	A	

Intersection Summary			
HCM Average Control Delay	6.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	29.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations				↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	468	978	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	509	1063	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1582	1073	1068			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1582	1073	1068			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	119	266	652			

Direction, Lane #	NE 1	SW 1
Volume Total	509	1063
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.30	0.63
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations				↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	468	978	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	509	1063	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1582	1073	1068			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1582	1073	1068			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	119	266	652			

Direction, Lane #	NE 1	SW 1
Volume Total	509	1063
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.30	0.63
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑							
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	468	0	0	978	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	509	0	0	1063	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1068			514			1582	1582	519	1582	1582	1073
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1068			514			1582	1582	519	1582	1582	1073
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	652			1052			88	109	555	88	109	266

Direction, Lane #	EB 1	WB 1
Volume Total	509	1063
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.30	0.63
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.09	1.00
Satd. Flow (perm)	1770	1583	3539	1583	161	3539
Volume (vph)	180	84	1454	380	226	1362
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	91	1580	413	246	1480
RTOR Reduction (vph)	0	76	0	186	0	0
Lane Group Flow (vph)	196	15	1580	227	246	1480
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	12.9	12.9	42.3	42.3	56.1	56.1
Effective Green, g (s)	12.9	12.9	42.3	42.3	56.1	56.1
Actuated g/C Ratio	0.17	0.17	0.55	0.55	0.73	0.73
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	297	265	1944	870	322	2578
v/s Ratio Prot	c0.11		c0.45		c0.10	0.42
v/s Ratio Perm		0.01		0.14	0.46	
v/c Ratio	0.66	0.06	0.81	0.26	0.76	0.57
Uniform Delay, d1	30.0	26.9	14.1	9.1	19.3	4.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.2	0.1	3.8	0.7	10.3	0.9
Delay (s)	35.2	27.0	18.0	9.9	29.6	5.8
Level of Service	D	C	B	A	C	A
Approach Delay (s)	32.6		16.3		9.2	
Approach LOS	C		B		A	

Intersection Summary			
HCM Average Control Delay	14.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	77.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.95	1.00	1.00	0.95
Frt	0.95	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3332	1441	3539	1583	1770	3539
Flt Permitted	0.97	1.00	1.00	1.00	0.11	1.00
Satd. Flow (perm)	3332	1441	3539	1583	200	3539
Volume (vph)	217	268	1493	140	205	1483
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	236	291	1623	152	223	1612
RTOR Reduction (vph)	82	156	0	72	0	0
Lane Group Flow (vph)	258	31	1623	80	223	1612
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	10.4	10.4	33.2	33.2	44.3	44.3
Effective Green, g (s)	10.4	10.4	33.2	33.2	44.3	44.3
Actuated g/C Ratio	0.17	0.17	0.53	0.53	0.71	0.71
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	553	239	1874	838	319	2500
v/s Ratio Prot	c0.08		c0.46		0.08	c0.46
v/s Ratio Perm		0.02		0.05	0.41	
v/c Ratio	0.47	0.13	0.87	0.10	0.70	0.64
Uniform Delay, d1	23.6	22.3	12.8	7.3	12.6	5.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6	0.2	4.5	0.1	6.6	0.6
Delay (s)	24.3	22.5	17.3	7.4	19.2	5.5
Level of Service	C	C	B	A	B	A
Approach Delay (s)	23.7		16.5			7.2
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	62.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	71.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.95	1.00	0.97	0.95
Frpb, ped/bikes	1.00	0.98	1.00	0.99	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1555	3539	1564	3433	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3433	1555	3539	1564	3433	3539
Volume (vph)	1081	639	1070	1038	499	1108
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1175	695	1163	1128	542	1204
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	1175	695	1163	1128	542	1204
Confl. Peds. (#/hr)		20		1	1	
Turn Type		Free		Free	Prot	
Protected Phases	8		2		1	6
Permitted Phases		Free		Free		
Actuated Green, G (s)	28.0	80.0	27.0	80.0	13.0	44.0
Effective Green, g (s)	28.0	80.0	27.0	80.0	13.0	44.0
Actuated g/C Ratio	0.35	1.00	0.34	1.00	0.16	0.55
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	1202	1555	1194	1564	558	1946
v/s Ratio Prot	c0.34		c0.33		c0.16	0.34
v/s Ratio Perm		0.45		0.72		
v/c Ratio	0.98	0.45	0.97	0.72	0.97	0.62
Uniform Delay, d1	25.7	0.0	26.2	0.0	33.3	12.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	20.5	0.9	20.5	2.9	30.7	1.5
Delay (s)	46.2	0.9	46.7	2.9	64.1	13.8
Level of Service	D	A	D	A	E	B
Approach Delay (s)	29.4		25.1			29.4
Approach LOS	C		C			C

Intersection Summary			
HCM Average Control Delay	27.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	998	489	17	1631	0	74
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1085	532	18	1773	0	80
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			1620		2012	546
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1620		2012	546
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		100	83
cM capacity (veh/h)			397		49	480

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1
Volume Total	542	542	532	18	886	886	80
Volume Left	0	0	0	18	0	0	0
Volume Right	0	0	532	0	0	0	80
cSH	1700	1700	1700	397	1700	1700	480
Volume to Capacity	0.32	0.32	0.31	0.05	0.52	0.52	0.17
Queue Length 95th (ft)	0	0	0	4	0	0	15
Control Delay (s)	0.0	0.0	0.0	14.5	0.0	0.0	14.0
Lane LOS				B			B
Approach Delay (s)	0.0			0.1			14.0
Approach LOS							B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	48.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.95	0.91	0.95	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	1681	1618	1504	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3539	1583	1770	3539	1583	1681	1618	1504	1770	1863	1583
Volume (vph)	268	644	111	118	869	94	398	10	293	130	10	358
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	291	700	121	128	945	102	433	11	318	141	11	389
RTOR Reduction (vph)	0	0	74	0	0	40	0	0	263	0	0	0
Lane Group Flow (vph)	291	700	47	128	945	62	221	223	55	141	11	389
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Free
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	15.5	32.3	32.3	8.9	25.7	25.7	14.3	14.3	14.3	11.5	11.5	83.0
Effective Green, g (s)	15.5	32.3	32.3	8.9	25.7	25.7	14.3	14.3	14.3	11.5	11.5	83.0
Actuated g/C Ratio	0.19	0.39	0.39	0.11	0.31	0.31	0.17	0.17	0.17	0.14	0.14	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	331	1377	616	190	1096	490	290	279	259	245	258	1583
v/s Ratio Prot	c0.16	0.20		0.07	c0.27		0.13	c0.14		c0.08	0.01	
v/s Ratio Perm			0.03			0.04			0.04			0.25
v/c Ratio	0.88	0.51	0.08	0.67	0.86	0.13	0.76	0.80	0.21	0.58	0.04	0.25
Uniform Delay, d1	32.8	19.3	16.0	35.7	27.0	20.6	32.7	33.0	29.5	33.5	31.0	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	22.2	0.3	0.1	9.1	7.2	0.1	11.2	14.7	0.4	3.3	0.1	0.4
Delay (s)	55.1	19.6	16.0	44.7	34.1	20.7	44.0	47.7	29.9	36.7	31.0	0.4
Level of Service	E	B	B	D	C	C	D	D	C	D	C	A
Approach Delay (s)		28.5			34.1			39.2			10.5	
Approach LOS		C			C			D			B	

Intersection Summary			
HCM Average Control Delay	29.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1534	1770	1863	1534	1770	1863	1554	1770	1863	1554
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3539	1534	1770	1863	1534	1770	1863	1554	1770	1863	1554
Volume (vph)	223	593	150	180	332	210	79	174	282	291	215	275
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	242	645	163	196	361	228	86	189	307	316	234	299
RTOR Reduction (vph)	0	0	123	0	0	177	0	0	252	0	0	208
Lane Group Flow (vph)	242	645	40	196	361	51	86	189	55	316	234	91
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			6
Actuated Green, G (s)	12.3	18.0	18.0	11.0	16.7	16.7	6.5	13.3	13.3	15.7	22.5	22.5
Effective Green, g (s)	12.3	18.0	18.0	11.0	16.7	16.7	6.5	13.3	13.3	15.7	22.5	22.5
Actuated g/C Ratio	0.17	0.24	0.24	0.15	0.23	0.23	0.09	0.18	0.18	0.21	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	294	861	373	263	420	346	155	335	279	376	566	473
v/s Ratio Prot	c0.14	0.18		0.11	c0.19		0.05	c0.10		c0.18	0.13	
v/s Ratio Perm			0.03			0.03			0.04			0.06
v/c Ratio	0.82	0.75	0.11	0.75	0.86	0.15	0.55	0.56	0.20	0.84	0.41	0.19
Uniform Delay, d1	29.8	25.9	21.8	30.2	27.5	23.0	32.4	27.7	25.8	27.9	20.5	19.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.8	3.6	0.1	10.9	15.9	0.2	4.3	2.2	0.3	15.4	0.5	0.2
Delay (s)	46.6	29.5	21.9	41.1	43.4	23.2	36.6	29.9	26.2	43.4	21.0	19.2
Level of Service	D	C	C	D	D	C	D	C	C	D	C	B
Approach Delay (s)		32.3			37.0			28.9			28.7	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	31.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	74.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.15	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	275	1863	1863	1583
Volume (vph)	539	420	250	666	495	343
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	586	457	272	724	538	373
RTOR Reduction (vph)	0	253	0	0	0	177
Lane Group Flow (vph)	586	204	272	724	538	196
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	25.0	25.0	36.1	36.1	23.1	23.1
Effective Green, g (s)	25.0	25.0	36.1	36.1	23.1	23.1
Actuated g/C Ratio	0.36	0.36	0.52	0.52	0.33	0.33
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	640	573	338	973	623	529
v/s Ratio Prot	c0.33		0.10	c0.39	0.29	
v/s Ratio Perm		0.13	c0.32			0.12
v/c Ratio	0.92	0.36	0.80	0.74	0.86	0.37
Uniform Delay, d1	21.0	16.1	13.1	12.9	21.5	17.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	17.8	0.4	13.0	5.1	14.7	2.0
Delay (s)	38.8	16.5	26.1	18.0	36.3	19.5
Level of Service	D	B	C	B	D	B
Approach Delay (s)	29.1			20.3	29.4	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	26.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	69.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.91	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected		0.96	1.00	0.95	0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1795	1583	1681	1691	1583	1770	3539	1583	1770	5069	
Flt Permitted		0.96	1.00	0.95	0.96	1.00	0.06	1.00	1.00	0.06	1.00	
Satd. Flow (perm)		1795	1583	1681	1691	1583	108	3539	1583	102	5069	
Volume (vph)	59	19	71	520	20	192	60	1684	365	143	2055	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	565	22	209	65	1830	397	155	2234	48
RTOR Reduction (vph)	0	0	47	0	0	96	0	0	180	0	2	0
Lane Group Flow (vph)	0	85	30	286	301	113	65	1830	217	155	2280	0
Turn Type	Split		Perm	Split		Perm	pm+pt		Perm	pm+pt		
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8	2		2	6		
Actuated Green, G (s)		11.2	11.2	23.0	23.0	23.0	72.1	68.9	68.9	79.7	72.7	
Effective Green, g (s)		11.2	11.2	23.0	23.0	23.0	72.1	68.9	68.9	79.7	72.7	
Actuated g/C Ratio		0.09	0.09	0.18	0.18	0.18	0.57	0.55	0.55	0.63	0.58	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		159	141	307	308	289	104	1934	865	157	2922	
v/s Ratio Prot		c0.05		0.17	c0.18		0.02	0.52		c0.05	0.45	
v/s Ratio Perm			0.02			0.07	0.34		0.14	c0.57		
v/c Ratio		0.53	0.21	0.93	0.98	0.39	0.62	0.95	0.25	0.99	0.78	
Uniform Delay, d1		55.0	53.3	50.8	51.3	45.4	20.0	26.9	15.0	39.1	20.6	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		3.4	0.7	33.8	44.6	0.9	11.1	11.2	0.7	67.4	2.1	
Delay (s)		58.4	54.1	84.6	95.9	46.3	31.1	38.1	15.7	106.5	22.7	
Level of Service		E	D	F	F	D	C	D	B	F	C	
Approach Delay (s)		56.3			78.8			34.0			28.0	
Approach LOS		E			E			C			C	

Intersection Summary				
HCM Average Control Delay	38.3	HCM Level of Service	D	
HCM Volume to Capacity ratio	0.96			
Actuated Cycle Length (s)	126.1	Sum of lost time (s)	16.0	
Intersection Capacity Utilization	86.1%	ICU Level of Service	E	
Analysis Period (min)	15			
c Critical Lane Group				

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	172	895	895	36	0	186
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	187	973	973	39	0	202
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)			1250			
pX, platoon unblocked						
vC, conflicting volume	1017				1843	496
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1017				1843	496
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	72				100	61
cM capacity (veh/h)	675				48	515

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	SB 1
Volume Total	187	486	486	486	486	39	202
Volume Left	187	0	0	0	0	0	0
Volume Right	0	0	0	0	0	39	202
cSH	675	1700	1700	1700	1700	1700	515
Volume to Capacity	0.28	0.29	0.29	0.29	0.29	0.02	0.39
Queue Length 95th (ft)	28	0	0	0	0	0	46
Control Delay (s)	12.4	0.0	0.0	0.0	0.0	0.0	16.4
Lane LOS	B						C
Approach Delay (s)	2.0			0.0			16.4
Approach LOS							C

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	49.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1544	1768	3539	1770	1560
Flt Permitted	1.00	1.00	0.29	1.00	0.95	1.00
Satd. Flow (perm)	3539	1544	547	3539	1770	1560
Volume (vph)	888	7	21	666	266	78
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	965	8	23	724	289	85
RTOR Reduction (vph)	0	5	0	0	0	28
Lane Group Flow (vph)	965	3	23	724	289	57
Confl. Peds. (#/hr)		5	5		5	5
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	13.6	13.6	13.6	13.6	10.5	10.5
Effective Green, g (s)	13.6	13.6	13.6	13.6	10.5	10.5
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.33	0.33
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1499	654	232	1499	579	510
v/s Ratio Prot	c0.27			0.20	c0.16	
v/s Ratio Perm		0.00	0.04			0.04
v/c Ratio	0.64	0.01	0.10	0.48	0.50	0.11
Uniform Delay, d1	7.3	5.3	5.6	6.7	8.7	7.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.0	0.0	0.2	0.2	0.7	0.1
Delay (s)	8.3	5.3	5.8	6.9	9.4	7.6
Level of Service	A	A	A	A	A	A
Approach Delay (s)	8.3			6.9	9.0	
Approach LOS	A			A	A	

Intersection Summary			
HCM Average Control Delay	7.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	32.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	1167	722	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	1268	785	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2063	795	790			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2063	795	790			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	60	386	830			

Direction, Lane #	NE 1	SW 1
Volume Total	1268	785
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.75	0.46
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	SBL	SBR	NBL	NBT	SWT	SWR
Lane Configurations				↑	↑	
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	0	0	1167	722	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	1268	785	0
Pedestrians	5			5	5	
Lane Width (ft)	0.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2063	795	790			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2063	795	790			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	60	386	830			

Direction, Lane #	NE 1	SW 1
Volume Total	1268	785
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.75	0.46
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑							
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1167	0	0	722	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	1268	0	0	785	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	790			1273			2063	2063	1278	2063	2063	795
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	790			1273			2063	2063	1278	2063	2063	795
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	830			545			40	55	202	40	55	386

Direction, Lane #	EB 1	WB 1
Volume Total	1268	785
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.75	0.46
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

Appendix J - Intersection Operations Analysis Worksheets for 2025 With Project Phase 2 Conditions, with Existing Geometry

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.04	1.00
Satd. Flow (perm)	1770	1583	1863	1583	69	1863
Volume (vph)	480	244	1533	102	33	1674
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	265	1666	111	36	1820
RTOR Reduction (vph)	0	38	0	31	0	0
Lane Group Flow (vph)	522	227	1666	80	36	1820
Turn Type		Perm		Perm	Perm	
Protected Phases	8		2			6
Permitted Phases		8		2	6	
Actuated Green, G (s)	34.0	34.0	108.0	108.0	108.0	108.0
Effective Green, g (s)	34.0	34.0	108.0	108.0	108.0	108.0
Actuated g/C Ratio	0.23	0.23	0.72	0.72	0.72	0.72
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	401	359	1341	1140	50	1341
v/s Ratio Prot	c0.29		0.89			c0.98
v/s Ratio Perm		0.14		0.05	0.52	
v/c Ratio	1.30	0.63	1.24	0.07	0.72	1.36
Uniform Delay, d1	58.0	52.4	21.0	6.2	12.2	21.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	153.0	3.6	115.6	0.1	62.0	165.7
Delay (s)	211.0	56.0	136.6	6.3	74.2	186.7
Level of Service	F	E	F	A	E	F
Approach Delay (s)	158.8		128.4			184.5
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	157.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.34		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	121.4%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	206	323	1341	287	366	1690
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	224	351	1458	312	398	1837
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	4090	1458			1458	
vC1, stage 1 conf vol	1458					
vC2, stage 2 conf vol	2633					
vCu, unblocked vol	4090	1458			1458	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	0			14	
cM capacity (veh/h)	8	159			464	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	575	1458	312	398	1837
Volume Left	224	0	0	398	0
Volume Right	351	0	312	0	0
cSH	18	1700	1700	464	1700
Volume to Capacity	31.20	0.86	0.18	0.86	1.08
Queue Length 95th (ft)	Err	0	0	219	0
Control Delay (s)	Err	0.0	0.0	44.1	0.0
Lane LOS	F			E	
Approach Delay (s)	Err	0.0		7.9	
Approach LOS	F				

Intersection Summary			
Average Delay	1259.3		
Intersection Capacity Utilization	112.3%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.95	1.00	0.95	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1511	1863	1501	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.08	1.00
Satd. Flow (perm)	1770	1511	1863	1501	152	1863
Volume (vph)	935	609	958	1340	787	1191
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1016	662	1041	1457	855	1295
RTOR Reduction (vph)	0	198	0	433	0	0
Lane Group Flow (vph)	1016	464	1041	1024	855	1295
Confl. Peds. (#/hr)		14		8	8	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	44.0	44.0	45.0	45.0	78.0	78.0
Effective Green, g (s)	44.0	44.0	45.0	45.0	78.0	78.0
Actuated g/C Ratio	0.34	0.34	0.35	0.35	0.60	0.60
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	599	511	645	520	452	1118
v/s Ratio Prot	c0.57		0.56		c0.42	0.70
v/s Ratio Perm		0.31		0.68	c0.71	
v/c Ratio	1.70	0.91	1.61	1.97	1.89	1.16
Uniform Delay, d1	43.0	41.0	42.5	42.5	52.7	26.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	320.4	19.7	283.4	443.2	409.5	81.5
Delay (s)	363.4	60.7	325.9	485.7	462.2	107.5
Level of Service	F	E	F	F	F	F
Approach Delay (s)	244.0		419.1			248.6
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	314.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.80		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	155.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations							
Sign Control		Free			Free	Stop	
Grade		0%			0%	0%	
Volume (veh/h)		1732	363	29	1339	0	18
Peak Hour Factor		0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)		1883	395	32	1455	0	20
Pedestrians						2	
Lane Width (ft)						12.0	
Walking Speed (ft/s)						4.0	
Percent Blockage						0	
Right turn flare (veh)							
Median type						None	
Median storage veh)							
Upstream signal (ft)		475					
pX, platoon unblocked							
vC, conflicting volume				2279		2675	1885
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol				2279		2675	1885
tC, single (s)				4.1		6.8	6.9
tC, 2 stage (s)							
tF (s)				2.2		3.5	3.3
p0 queue free %				86		100	68
cM capacity (veh/h)				219		15	60

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1883	395	517	970	20
Volume Left	0	0	32	0	0
Volume Right	0	395	0	0	20
cSH	1700	1700	219	1700	60
Volume to Capacity	1.11	0.23	0.14	0.57	0.32
Queue Length 95th (ft)	0	0	12	0	29
Control Delay (s)	0.0	0.0	6.0	0.0	91.0
Lane LOS			A		F
Approach Delay (s)	0.0		2.1		91.0
Approach LOS					F

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	101.2%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	430	1043	264	255	1033	126	232	10	88	87	10	337
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	467	1134	287	277	1123	137	252	11	96	95	11	366
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1260			1134			3934	3883	1134	3867	3814	1191
vC1, stage 1 conf vol							2068	2068				
vC2, stage 2 conf vol							1866	1814				
vCu, unblocked vol	1260			1134			3934	3883	1134	3867	3814	1191
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	15			55			0	0	61	0	0	0
cM capacity (veh/h)	552			616			0	0	247	0	0	228

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	1601	287	277	1260	359	472
Volume Left	467	0	277	0	252	95
Volume Right	0	287	0	137	96	366
cSH	552	1700	616	1700	0	0
Volume to Capacity	0.85	0.17	0.45	0.74	Err	Err
Queue Length 95th (ft)	224	0	58	0	Err	Err
Control Delay (s)	78.8	0.0	15.5	0.0	Err	Err
Lane LOS	F		C		F	F
Approach Delay (s)	66.8		2.8		Err	Err
Approach LOS					F	F

Intersection Summary			
Average Delay	1981.9		
Intersection Capacity Utilization	170.7%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	496	382	97	278	753	342	278	318	148	253	222	319
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	539	415	105	302	818	372	302	346	161	275	241	347
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1195			526			3220	3298	425	3180	3032	828
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1195			526			3220	3298	425	3180	3032	828
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	7			71			0	0	74	0	0	6
cM capacity (veh/h)	582			1037			0	0	624	0	1	368

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	539	415	105	302	818	372	302	507	275	588
Volume Left	539	0	0	302	0	0	302	0	275	0
Volume Right	0	0	105	0	0	372	0	161	0	347
cSH	582	1700	1700	1037	1700	1700	0	1	0	2
Volume to Capacity	0.93	0.24	0.06	0.29	0.48	0.22	Err	782.58	Err	364.43
Queue Length 95th (ft)	295	0	0	30	0	0	Err	Err	Err	Err
Control Delay (s)	48.2	0.0	0.0	9.9	0.0	0.0	Err	Err	Err	Err
Lane LOS	E			A			F	F	F	F
Approach Delay (s)	24.5			2.0			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	111.2%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.04	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	79	1863	1863	1583
Volume (vph)	326	330	459	437	1512	565
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	354	359	499	475	1643	614
RTOR Reduction (vph)	0	211	0	0	0	45
Lane Group Flow (vph)	354	148	499	475	1643	569
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	24.0	24.0	118.0	118.0	90.0	90.0
Effective Green, g (s)	24.0	24.0	118.0	118.0	90.0	90.0
Actuated g/C Ratio	0.16	0.16	0.79	0.79	0.60	0.60
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	283	253	333	1466	1118	950
v/s Ratio Prot	c0.20		c0.24	0.26	0.88	
v/s Ratio Perm		0.09	c0.94			0.36
v/c Ratio	1.25	0.59	1.50	0.32	1.47	0.60
Uniform Delay, d1	63.0	58.4	65.2	4.6	30.0	18.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	138.7	3.4	239.5	0.6	216.2	2.8
Delay (s)	201.7	61.8	304.7	5.2	246.2	21.5
Level of Service	F	E	F	A	F	C
Approach Delay (s)	131.3			158.6	185.1	
Approach LOS	F			F	F	

Intersection Summary			
HCM Average Control Delay	168.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.44		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	133.1%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1800	1583		1777	1583	1770	1863	1549	1770	1863	1549
Flt Permitted		0.38	1.00		0.72	1.00	0.13	1.00	1.00	0.08	1.00	1.00
Satd. Flow (perm)		702	1583		1333	1583	250	1863	1549	145	1863	1549
Volume (vph)	17	7	24	441	18	166	68	2176	695	240	1697	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	479	20	180	74	2365	755	261	1845	52
RTOR Reduction (vph)	0	0	20	0	0	38	0	0	176	0	0	16
Lane Group Flow (vph)	0	26	6	0	499	142	74	2365	579	261	1845	36
Confl. Peds. (#/hr)							2		2	2		2
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		36.0	36.0		36.0	36.0	99.0	95.0	95.0	105.0	98.0	98.0
Effective Green, g (s)		36.0	36.0		36.0	36.0	99.0	95.0	95.0	105.0	98.0	98.0
Actuated g/C Ratio		0.24	0.24		0.24	0.24	0.66	0.63	0.63	0.70	0.65	0.65
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		168	380		320	380	206	1180	981	177	1217	1012
v/s Ratio Prot							0.01	c1.27		c0.07	0.99	
v/s Ratio Perm		0.04	0.00		c0.37	0.09	0.23		0.37	0.96		0.02
v/c Ratio		0.15	0.02		1.56	0.37	0.36	2.00	0.59	1.47	1.52	0.04
Uniform Delay, d1		45.0	43.5		57.0	47.6	9.0	27.5	16.1	20.1	26.0	9.2
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.4	0.0		266.5	0.6	1.1	454.9	2.6	241.5	236.5	0.1
Delay (s)		45.4	43.5		323.5	48.2	10.1	482.4	18.7	261.6	262.5	9.3
Level of Service		D	D		F	D	B	F	B	F	F	A
Approach Delay (s)		44.5			250.5			361.9			256.3	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	309.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.92		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	169.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	215	1002	1267	29	0	147
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	234	1089	1377	32	0	160
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1414				2944	1387
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1414				2944	1387
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	51				100	8
cM capacity (veh/h)	480				8	174

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	234	1089	1377	32	160
Volume Left	234	0	0	0	0
Volume Right	0	0	0	32	160
cSH	480	1700	1700	1700	174
Volume to Capacity	0.49	0.64	0.81	0.02	0.92
Queue Length 95th (ft)	66	0	0	0	173
Control Delay (s)	19.4	0.0	0.0	0.0	102.3
Lane LOS	C				F
Approach Delay (s)	3.4		0.0		102.3
Approach LOS					F

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	93.5%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	933	70	209	1141	155	43
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1014	76	227	1240	168	47
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1095		2719	1024
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1095		2719	1024
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			64		0	84
cM capacity (veh/h)			635		15	283

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1014	76	227	1240	215
Volume Left	0	0	227	0	168
Volume Right	0	76	0	0	47
cSH	1700	1700	635	1700	18
Volume to Capacity	0.60	0.04	0.36	0.73	11.70
Queue Length 95th (ft)	0	0	41	0	Err
Control Delay (s)	0.0	0.0	13.8	0.0	Err
Lane LOS			B		F
Approach Delay (s)	0.0		2.1		Err
Approach LOS					F

Intersection Summary			
Average Delay	777.2		
Intersection Capacity Utilization	80.0%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	142	266	254	530	1107	93
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	154	289	276	576	1203	101
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2342	1213	1309			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2342	1213	1309			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	0	48			
cM capacity (veh/h)	19	220	526			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	154	289	276	576	1203	101
Volume Left	154	0	276	0	0	0
Volume Right	0	289	0	0	0	101
cSH	19	220	526	1700	1700	1700
Volume to Capacity	8.18	1.32	0.52	0.34	0.71	0.06
Queue Length 95th (ft)	Err	390	75	0	0	0
Control Delay (s)	Err	214.0	19.1	0.0	0.0	0.0
Lane LOS	F	F	C			
Approach Delay (s)	3619.5		6.2		0.0	
Approach LOS	F					

Intersection Summary			
Average Delay	619.4		
Intersection Capacity Utilization	91.0%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	672	1200	42
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	730	1304	46
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2067	1314	1355			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2067	1314	1355			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	94	98			
cM capacity (veh/h)	58	192	506			

Direction, Lane #	SB 1	NE 1	NE 2	SW 1	SW 2
Volume Total	11	11	730	1304	46
Volume Left	0	11	0	0	0
Volume Right	11	0	0	0	46
cSH	192	506	1700	1700	1700
Volume to Capacity	0.06	0.02	0.43	0.77	0.03
Queue Length 95th (ft)	4	2	0	0	0
Control Delay (s)	24.9	12.3	0.0	0.0	0.0
Lane LOS	C	B			
Approach Delay (s)	24.9	0.2		0.0	
Approach LOS	C				

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	74.7%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	672	0	0	1242	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	730	0	0	1350	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1355			735			2090	2090	740	2090	2090	1360
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1355			735			2090	2090	740	2090	2090	1360
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	508			870			38	53	415	38	53	181

Direction, Lane #	EB 1	WB 1
Volume Total	730	1350
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.43	0.79
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.09	1.00
Satd. Flow (perm)	1770	1583	1863	1583	174	1863
Volume (vph)	180	84	2003	380	226	1870
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	91	2177	413	246	2033
RTOR Reduction (vph)	0	75	0	96	0	0
Lane Group Flow (vph)	196	16	2177	317	246	2033
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	16.0	16.0	115.0	115.0	126.0	126.0
Effective Green, g (s)	16.0	16.0	115.0	115.0	126.0	126.0
Actuated g/C Ratio	0.11	0.11	0.77	0.77	0.84	0.84
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	189	169	1428	1214	221	1565
v/s Ratio Prot	c0.11		c1.17		0.05	c1.09
v/s Ratio Perm		0.01		0.20	0.88	
v/c Ratio	1.04	0.09	1.52	0.26	1.11	1.30
Uniform Delay, d1	67.0	60.5	17.5	5.1	18.4	12.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	75.5	0.2	239.6	0.5	94.2	139.4
Delay (s)	142.5	60.7	257.1	5.6	112.6	151.4
Level of Service	F	E	F	A	F	F
Approach Delay (s)	116.6		217.0			147.2
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	180.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.47		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	137.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Hulikoa Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	268	370	1940	189	302	1892
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	291	402	2109	205	328	2057
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	4822	2109			2109	
vC1, stage 1 conf vol	2109					
vC2, stage 2 conf vol	2713					
vCu, unblocked vol	4822	2109			2109	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	0			0	
cM capacity (veh/h)	0	64			260	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	693	2109	205	328	2057
Volume Left	291	0	0	328	0
Volume Right	402	0	205	0	0
cSH	0	1700	1700	260	1700
Volume to Capacity	Err	1.24	0.12	1.26	1.21
Queue Length 95th (ft)	Err	0	0	405	0
Control Delay (s)	Err	0.0	0.0	185.4	0.0
Lane LOS	F			F	
Approach Delay (s)	Err	0.0		25.5	
Approach LOS	F				

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	143.7%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.94	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1483	1863	1545	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	1770	1483	1863	1545	135	1863
Volume (vph)	1439	908	1296	1352	683	1383
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1564	987	1409	1470	742	1503
RTOR Reduction (vph)	0	179	0	505	0	0
Lane Group Flow (vph)	1564	808	1409	965	742	1503
Confl. Peds. (#/hr)		20		1	1	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	56.0	56.0	51.0	51.0	76.0	76.0
Effective Green, g (s)	56.0	56.0	51.0	51.0	76.0	76.0
Actuated g/C Ratio	0.40	0.40	0.36	0.36	0.54	0.54
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	708	593	679	563	319	1011
v/s Ratio Prot	c0.88		0.76		c0.35	0.81
v/s Ratio Perm		0.55		0.62	c0.91	
v/c Ratio	2.21	1.36	2.08	1.71	2.33	1.49
Uniform Delay, d1	42.0	42.0	44.5	44.5	61.7	32.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	548.7	174.0	488.9	329.0	606.4	224.3
Delay (s)	590.7	216.0	533.4	373.5	668.1	256.3
Level of Service	F	F	F	F	F	F
Approach Delay (s)	445.7		451.7			392.4
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	432.4	HCM Level of Service	F
HCM Volume to Capacity ratio	2.25		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	195.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1496	489	17	2259	0	74
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1626	532	18	2455	0	80
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			2162		2895	1630
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2162		2895	1630
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		100	11
cM capacity (veh/h)			244		12	90

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1626	532	837	1637	80
Volume Left	0	0	18	0	0
Volume Right	0	532	0	0	80
cSH	1700	1700	244	1700	90
Volume to Capacity	0.96	0.31	0.08	0.96	0.89
Queue Length 95th (ft)	0	0	6	0	123
Control Delay (s)	0.0	0.0	3.5	0.0	149.4
Lane LOS			A		F
Approach Delay (s)	0.0		1.2		149.4
Approach LOS					F

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	100.3%	ICU Level of Service	G
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Hina Lani Street & Kamanu Street

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	366	1017	140	141	1305	94	487	10	378	130	10	460
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	398	1105	152	153	1418	102	529	11	411	141	11	500
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1521			1105			3882	3728	1105	3888	3677	1470
vC1, stage 1 conf vol							1901	1901				
vC2, stage 2 conf vol							1980	1827				
vCu, unblocked vol	1521			1105			3882	3728	1105	3888	3677	1470
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	9			76			0	0	0	0	0	0
cM capacity (veh/h)	439			632			0	0	256	0	0	156

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	1503	152	153	1521	951	652
Volume Left	398	0	153	0	529	141
Volume Right	0	152	0	102	411	500
cSH	439	1700	632	1700	0	0
Volume to Capacity	0.91	0.09	0.24	0.89	Err	Err
Queue Length 95th (ft)	248	0	24	0	Err	Err
Control Delay (s)	116.7	0.0	12.5	0.0	Err	Err
Lane LOS	F		B		F	F
Approach Delay (s)	106.0		1.1		Err	Err
Approach LOS					F	F

Intersection Summary			
Average Delay	3286.0		
Intersection Capacity Utilization	192.3%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keahokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	389	873	277	282	559	259	113	251	380	342	297	449
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	423	949	301	307	608	282	123	273	413	372	323	488
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	894			1255			3431	3307	959	3368	3326	618
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	894			1255			3431	3307	959	3368	3326	618
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	44			44			0	0	0	0	0	0
cM capacity (veh/h)	756			552			0	2	309	0	2	485

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	423	949	301	307	608	282	123	686	372	811
Volume Left	423	0	0	307	0	0	123	0	372	0
Volume Right	0	0	301	0	0	282	0	413	0	488
cSH	756	1700	1700	552	1700	1700	0	4	0	4
Volume to Capacity	0.56	0.56	0.18	0.56	0.36	0.17	Err	166.60	Err	202.54
Queue Length 95th (ft)	88	0	0	84	0	0	Err	Err	Err	Err
Control Delay (s)	15.6	0.0	0.0	19.4	0.0	0.0	Err	Err	Err	Err
Lane LOS	C			C			F	F	F	F
Approach Delay (s)	4.0			5.0			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	107.1%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.11	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	196	1863	1863	1583
Volume (vph)	683	554	363	850	635	452
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	742	602	395	924	690	491
RTOR Reduction (vph)	0	247	0	0	0	128
Lane Group Flow (vph)	742	355	395	924	690	363
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	38.0	38.0	54.0	54.0	34.0	34.0
Effective Green, g (s)	38.0	38.0	54.0	54.0	34.0	34.0
Actuated g/C Ratio	0.38	0.38	0.54	0.54	0.34	0.34
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	673	602	358	1006	633	538
v/s Ratio Prot	c0.42		c0.18	0.50	0.37	
v/s Ratio Perm		0.22	c0.42			0.23
v/c Ratio	1.10	0.59	1.10	0.92	1.09	0.67
Uniform Delay, d1	31.0	24.8	44.2	21.0	33.0	28.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	66.2	1.5	78.4	14.5	62.7	6.6
Delay (s)	97.2	26.2	122.6	35.5	95.7	34.9
Level of Service	F	C	F	D	F	C
Approach Delay (s)	65.4			61.5	70.5	
Approach LOS	E			E	E	

Intersection Summary			
HCM Average Control Delay	65.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1795	1583		1777	1583	1770	1863	1583	1770	1863	1583
Flt Permitted		0.12	1.00		0.66	1.00	0.05	1.00	1.00	0.08	1.00	1.00
Satd. Flow (perm)		229	1583		1226	1583	89	1863	1583	142	1863	1583
Volume (vph)	59	19	71	665	20	192	60	2225	460	143	2689	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	723	22	209	65	2418	500	155	2923	48
RTOR Reduction (vph)	0	0	33	0	0	33	0	0	114	0	0	9
Lane Group Flow (vph)	0	85	44	0	745	176	65	2418	386	155	2923	39
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		50.0	50.0		50.0	50.0	88.0	84.0	84.0	88.0	84.0	84.0
Effective Green, g (s)		50.0	50.0		50.0	50.0	88.0	84.0	84.0	88.0	84.0	84.0
Actuated g/C Ratio		0.33	0.33		0.33	0.33	0.59	0.56	0.56	0.59	0.56	0.56
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		76	528		409	528	97	1043	886	127	1043	886
v/s Ratio Prot							0.02	1.30		c0.03	c1.57	
v/s Ratio Perm		0.37	0.03		c0.61	0.11	0.38		0.24	0.69		0.02
v/c Ratio		1.12	0.08		1.82	0.33	0.67	2.32	0.44	1.22	2.80	0.04
Uniform Delay, d1		50.0	34.3		50.0	37.5	13.3	33.0	19.2	16.8	33.0	14.9
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		139.0	0.1		379.2	0.4	16.7	596.3	1.6	150.8	813.8	0.1
Delay (s)		189.0	34.3		429.2	37.9	30.0	629.3	20.8	167.6	846.8	15.0
Level of Service		F	C		F	D	C	F	C	F	F	B
Approach Delay (s)		115.5			343.5			514.2			800.3	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	606.5	HCM Level of Service	F
HCM Volume to Capacity ratio	2.40		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	193.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	172	1353	1354	36	0	186
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	187	1471	1472	39	0	202
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1516				3326	1482
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1516				3326	1482
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	57				100	0
cM capacity (veh/h)	439				5	152

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	187	1471	1472	39	202
Volume Left	187	0	0	0	0
Volume Right	0	0	0	39	202
cSH	439	1700	1700	1700	152
Volume to Capacity	0.43	0.87	0.87	0.02	1.33
Queue Length 95th (ft)	52	0	0	0	309
Control Delay (s)	19.2	0.0	0.0	0.0	241.4
Lane LOS	C				F
Approach Delay (s)	2.2		0.0		241.4
Approach LOS					F

Intersection Summary			
Average Delay	15.5		
Intersection Capacity Utilization	95.7%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1334	18	55	1065	323	205
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1450	20	60	1158	351	223
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1475		2737	1460
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1475		2737	1460
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			87		0	0
cM capacity (veh/h)			455		19	157

Direction, Lane #	EB 1	EB 2	WB	WB 2	NB 1
Volume Total	1450	20	60	1158	574
Volume Left	0	0	60	0	351
Volume Right	0	20	0	0	223
cSH	1700	1700	455	1700	29
Volume to Capacity	0.85	0.01	0.13	0.68	19.68
Queue Length 95th (ft)	0	0	11	0	Err
Control Delay (s)	0.0	0.0	14.1	0.0	Err
Lane LOS			B		F
Approach Delay (s)	0.0		0.7		Err
Approach LOS					F

Intersection Summary			
Average Delay	1760.1		
Intersection Capacity Utilization	94.8%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	163	306	293	1303	794	107
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	177	333	318	1416	863	116
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2926	873	984			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2926	873	984			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	4	54			
cM capacity (veh/h)	9	347	699			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	177	333	318	1416	863	116
Volume Left	177	0	318	0	0	0
Volume Right	0	333	0	0	0	116
cSH	9	347	699	1700	1700	1700
Volume to Capacity	19.53	0.96	0.46	0.83	0.51	0.07
Queue Length 95th (ft)	Err	258	60	0	0	0
Control Delay (s)	Err	73.9	14.4	0.0	0.0	0.0
Lane LOS	F	F	B			
Approach Delay (s)	3523.4		2.6		0.0	
Approach LOS	F					

Intersection Summary			
Average Delay	558.6		
Intersection Capacity Utilization	84.9%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	1466	901	49
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	1593	979	53
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2605	989	1038			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2605	989	1038			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	96	98			
cM capacity (veh/h)	26	297	667			

Direction, Lane #	SB 1	NE 1	NE 2	SW 1	SW 2
Volume Total	11	11	1593	979	53
Volume Left	0	11	0	0	0
Volume Right	11	0	0	0	53
cSH	297	667	1700	1700	1700
Volume to Capacity	0.04	0.02	0.94	0.58	0.03
Queue Length 95th (ft)	3	1	0	0	0
Control Delay (s)	17.6	10.5	0.0	0.0	0.0
Lane LOS	C	B			
Approach Delay (s)	17.6	0.1		0.0	
Approach LOS	C				

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	88.7%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑							
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1466	0	0	950	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	1593	0	0	1033	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1038			1598			2636	2636	1603	2636	2636	1043
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1038			1598			2636	2636	1603	2636	2636	1043
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	670			410			15	23	130	15	23	278

Direction, Lane #	EB 1	WB 1
Volume Total	1593	1033
Volume Left	0	0
Volume Right	0	0
cSH	1700	1700
Volume to Capacity	0.94	0.61
Queue Length 95th (ft)	0	0
Control Delay (s)	0.0	0.0
Lane LOS		
Approach Delay (s)	0.0	0.0
Approach LOS		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	80.5%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.09	1.00
Satd. Flow (perm)	3433	1583	3539	1583	159	3539
Volume (vph)	480	244	1533	102	33	1674
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	265	1666	111	36	1820
RTOR Reduction (vph)	0	94	0	44	0	0
Lane Group Flow (vph)	522	171	1666	67	36	1820
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	14.7	14.7	42.9	42.9	48.5	48.5
Effective Green, g (s)	14.7	14.7	42.9	42.9	48.5	48.5
Actuated g/C Ratio	0.21	0.21	0.60	0.60	0.68	0.68
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	709	327	2132	954	145	2411
v/s Ratio Prot	c0.15		0.47		0.01	c0.51
v/s Ratio Perm		0.11		0.04	0.16	
v/c Ratio	0.74	0.52	0.78	0.07	0.25	0.75
Uniform Delay, d1	26.4	25.1	10.6	5.9	9.3	7.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.0	1.5	2.9	0.1	0.9	2.3
Delay (s)	30.4	26.6	13.6	6.0	10.2	9.7
Level of Service	C	C	B	A	B	A
Approach Delay (s)	29.1		13.1			9.7
Approach LOS	C		B			A

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	71.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.95	1.00	0.97	0.95
Frt	0.94	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3298	1441	3539	1583	3433	3539
Flt Permitted	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3298	1441	3539	1583	3433	3539
Volume (vph)	206	323	1341	287	366	1690
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	224	351	1458	312	398	1837
RTOR Reduction (vph)	126	169	0	152	0	0
Lane Group Flow (vph)	248	32	1458	160	398	1837
Turn Type		Perm		Perm	Prot	
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	10.3	10.3	33.1	33.1	9.0	46.1
Effective Green, g (s)	10.3	10.3	33.1	33.1	9.0	46.1
Actuated g/C Ratio	0.16	0.16	0.51	0.51	0.14	0.72
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	527	230	1819	814	480	2533
v/s Ratio Prot	c0.08		c0.41		0.12	c0.52
v/s Ratio Perm		0.02		0.10		
v/c Ratio	0.47	0.14	0.80	0.20	0.83	0.73
Uniform Delay, d1	24.6	23.2	12.9	8.5	27.0	5.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7	0.3	3.8	0.5	11.3	1.8
Delay (s)	25.2	23.5	16.8	9.0	38.3	7.3
Level of Service	C	C	B	A	D	A
Approach Delay (s)	24.6		15.4			12.8
Approach LOS	C		B			B

Intersection Summary			
HCM Average Control Delay	15.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	64.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
4: Hina Lani Street & Kanalani Street

6/24/2011

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1732	363	29	1564	0	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1883	395	32	1700	0	20
Pedestrians					2	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			2279		2514	630
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2279		2514	630
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			86		100	95
cM capacity (veh/h)			219		20	424

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1
Volume Total	628	628	628	395	32	567	567	567	20
Volume Left	0	0	0	0	32	0	0	0	0
Volume Right	0	0	0	395	0	0	0	0	20
cSH	1700	1700	1700	1700	219	1700	1700	1700	424
Volume to Capacity	0.37	0.37	0.37	0.23	0.14	0.33	0.33	0.33	0.05
Queue Length 95th (ft)	0	0	0	0	12	0	0	0	4
Control Delay (s)	0.0	0.0	0.0	0.0	24.2	0.0	0.0	0.0	13.9
Lane LOS					C				B
Approach Delay (s)	0.0				0.4				13.9
Approach LOS									B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	43.5%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
5: Hina Lani Street & Kamanu Street

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.95	0.91	0.95	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.96	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	1681	1621	1504	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.96	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	1681	1621	1504	1770	1863	1583
Volume (vph)	430	1043	264	255	1033	126	232	10	88	87	10	337
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	467	1134	287	277	1123	137	252	11	96	95	11	366
RTOR Reduction (vph)	0	0	90	0	0	43	0	0	82	0	0	0
Lane Group Flow (vph)	467	1134	197	277	1123	94	131	132	14	95	11	366
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Free
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	13.4	28.2	28.2	14.1	28.9	28.9	11.4	11.4	11.4	9.9	9.9	79.6
Effective Green, g (s)	13.4	28.2	28.2	14.1	28.9	28.9	11.4	11.4	11.4	9.9	9.9	79.6
Actuated g/C Ratio	0.17	0.35	0.35	0.18	0.36	0.36	0.14	0.14	0.14	0.12	0.12	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	578	1254	561	314	1285	575	241	232	215	220	232	1583
v/s Ratio Prot	0.14	c0.32		c0.16	0.32		0.08	c0.08		c0.05	0.01	
v/s Ratio Perm			0.12			0.06			0.01			c0.23
v/c Ratio	0.81	0.90	0.35	0.88	0.87	0.16	0.54	0.57	0.06	0.43	0.05	0.23
Uniform Delay, d1	31.9	24.4	18.9	31.9	23.7	17.2	31.7	31.8	29.5	32.2	30.7	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.1	9.4	0.4	23.9	6.9	0.1	2.5	3.2	0.1	1.4	0.1	0.3
Delay (s)	40.0	33.8	19.3	55.8	30.5	17.3	34.2	35.0	29.6	33.6	30.8	0.3
Level of Service	D	C	B	E	C	B	C	C	C	C	C	A
Approach Delay (s)		33.1			33.9			33.3			7.7	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	30.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	79.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	67.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keohokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1552	3433	3539	1552	1770	1863	1552	3433	1863	1562
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1552	3433	3539	1552	1770	1863	1552	3433	1863	1562
Volume (vph)	496	382	97	278	753	342	278	318	148	253	222	319
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	539	415	105	302	818	372	302	346	161	275	241	347
RTOR Reduction (vph)	0	0	87	0	0	244	0	0	123	0	0	0
Lane Group Flow (vph)	539	415	18	302	818	128	302	346	38	275	241	347
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	15.4	14.6	14.6	23.4	22.6	22.6	16.8	19.9	19.9	11.1	14.2	85.0
Effective Green, g (s)	15.4	14.6	14.6	23.4	22.6	22.6	16.8	19.9	19.9	11.1	14.2	85.0
Actuated g/C Ratio	0.18	0.17	0.17	0.28	0.27	0.27	0.20	0.23	0.23	0.13	0.17	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	622	608	267	945	941	413	350	436	363	448	311	1562
v/s Ratio Prot	c0.16	0.12		0.09	c0.23		c0.17	c0.19		0.08	0.13	
v/s Ratio Perm			0.01			0.08			0.02			0.22
v/c Ratio	0.87	0.68	0.07	0.32	0.87	0.31	0.86	0.79	0.10	0.61	0.77	0.22
Uniform Delay, d1	33.8	33.0	29.5	24.5	29.8	25.0	33.0	30.6	25.6	34.9	33.9	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.1	3.2	0.1	0.2	8.6	0.4	19.2	9.6	0.1	2.5	11.4	0.3
Delay (s)	45.9	36.2	29.6	24.7	38.4	25.4	52.1	40.2	25.7	37.4	45.3	0.3
Level of Service	D	D	C	C	D	C	D	D	C	D	D	A
Approach Delay (s)		40.5			32.4			41.8			24.7	
Approach LOS		D			C			D			C	

Intersection Summary				
HCM Average Control Delay	34.6	HCM Level of Service	C	
HCM Volume to Capacity ratio	0.83			
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	75.6%	ICU Level of Service	D	
Analysis Period (min)	15			

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
7: Hina Lani Street & Mamalahoa Highway

7/22/2011

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1583	1770	1863	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1583	1770	1863	3539	1583
Volume (vph)	326	330	459	437	1512	565
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	354	359	499	475	1643	614
RTOR Reduction (vph)	0	5	0	0	0	41
Lane Group Flow (vph)	354	354	499	475	1643	573
Turn Type		pm+ov	Prot			pm+ov
Protected Phases	4	5	5	2	6	4
Permitted Phases		4				6
Actuated Green, G (s)	16.0	47.0	31.0	86.0	51.0	67.0
Effective Green, g (s)	16.0	47.0	31.0	86.0	51.0	67.0
Actuated g/C Ratio	0.15	0.43	0.28	0.78	0.46	0.61
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	499	734	499	1457	1641	1022
v/s Ratio Prot	c0.10	0.14	c0.28	0.26	c0.46	0.09
v/s Ratio Perm		0.09				0.30
v/c Ratio	0.71	0.48	1.00	0.33	1.00	0.56
Uniform Delay, d1	44.8	22.7	39.5	3.5	29.5	12.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.6	0.5	40.3	0.6	22.5	0.7
Delay (s)	49.4	23.2	79.8	4.1	52.0	13.5
Level of Service	D	C	E	A	D	B
Approach Delay (s)	36.2			42.9	41.5	
Approach LOS	D			D	D	

Intersection Summary				
HCM Average Control Delay	40.9	HCM Level of Service	D	
HCM Volume to Capacity ratio	0.95			
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	86.5%	ICU Level of Service	E	
Analysis Period (min)	15			

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	0.95	0.95	1.00	1.00	0.91	1.00	1.00	0.91	
Frpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected		0.97	1.00	0.95	0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1800	1583	1681	1692	1583	1769	5085	1549	1770	5061	
Flt Permitted		0.97	1.00	0.95	0.96	1.00	0.10	1.00	1.00	0.07	1.00	
Satd. Flow (perm)		1800	1583	1681	1692	1583	193	5085	1549	122	5061	
Volume (vph)	17	7	24	441	18	166	68	2176	695	240	1697	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	479	20	180	74	2365	755	261	1845	52
RTOR Reduction (vph)	0	0	16	0	0	150	0	0	362	0	2	0
Lane Group Flow (vph)	0	26	10	243	256	30	74	2365	393	261	1895	0
Confl. Peds. (#/hr)							2		2			2
Turn Type	Split		Perm	Split		Perm	Perm		Perm	pm+pt		
Protected Phases	4	4		8	8			2		1	6	
Permitted Phases			4			8	2		2	6		
Actuated Green, G (s)		5.5	5.5	18.1	18.1	18.1	57.2	57.2	57.2	74.3	74.3	
Effective Green, g (s)		5.5	5.5	18.1	18.1	18.1	57.2	57.2	57.2	74.3	74.3	
Actuated g/C Ratio		0.05	0.05	0.16	0.16	0.16	0.52	0.52	0.52	0.68	0.68	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		90	79	277	279	261	100	2647	806	279	3422	
v/s Ratio Prot		c0.01		0.14	c0.15			0.47		c0.11	0.37	
v/s Ratio Perm			0.01			0.02	0.38		0.25	c0.52		
v/c Ratio		0.29	0.12	0.88	0.92	0.11	0.74	0.89	0.49	0.94	0.55	
Uniform Delay, d1		50.3	49.9	44.8	45.2	39.1	20.6	23.6	16.9	35.5	9.2	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		1.8	0.7	25.2	32.7	0.2	38.5	5.1	2.1	36.7	0.7	
Delay (s)		52.1	50.6	70.1	77.8	39.3	59.1	28.8	19.0	72.1	9.9	
Level of Service		D	D	E	E	D	E	C	B	E	A	
Approach Delay (s)		51.4			64.8			27.2			17.4	
Approach LOS		D			E			C			B	

Intersection Summary				
HCM Average Control Delay	28.1	HCM Level of Service	C	
HCM Volume to Capacity ratio	0.88			
Actuated Cycle Length (s)	109.9	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	84.7%	ICU Level of Service	E	
Analysis Period (min)	15			

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	215	1002	1267	29	0	147
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	234	1089	1377	32	0	160
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					TWLTL	
Median storage veh)					3	
Upstream signal (ft)			1250			
pX, platoon unblocked	0.86				0.86	0.86
vC, conflicting volume	1414				2399	699
vC1, stage 1 conf vol					1382	
vC2, stage 2 conf vol					1017	
vCu, unblocked vol	1318				2464	486
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)	2.2				3.5	3.3
p0 queue free %	48				100	64
cM capacity (veh/h)	445				125	449

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	SB 1
Volume Total	234	545	545	689	689	32	160
Volume Left	234	0	0	0	0	0	0
Volume Right	0	0	0	0	0	32	160
cSH	445	1700	1700	1700	1700	1700	449
Volume to Capacity	0.52	0.32	0.32	0.41	0.41	0.02	0.36
Queue Length 95th (ft)	74	0	0	0	0	0	40
Control Delay (s)	21.7	0.0	0.0	0.0	0.0	0.0	17.4
Lane LOS	C						C
Approach Delay (s)	3.8			0.0			17.4
Approach LOS							C

Intersection Summary				
Average Delay	2.7			
Intersection Capacity Utilization	61.8%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frpb, ped/bikes	1.00	0.97	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1539	1767	3539	1770	1557
Flt Permitted	1.00	1.00	0.25	1.00	0.95	1.00
Satd. Flow (perm)	3539	1539	462	3539	1770	1557
Volume (vph)	933	70	209	1141	155	43
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1014	76	227	1240	168	47
RTOR Reduction (vph)	0	28	0	0	0	37
Lane Group Flow (vph)	1014	48	227	1240	168	10
Confl. Peds. (#/hr)		5	5		5	5
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	31.8	31.8	31.8	31.8	10.6	10.6
Effective Green, g (s)	31.8	31.8	31.8	31.8	10.6	10.6
Actuated g/C Ratio	0.63	0.63	0.63	0.63	0.21	0.21
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2233	971	292	2233	372	327
v/s Ratio Prot	0.29			0.35	c0.09	
v/s Ratio Perm		0.03	c0.49			0.01
v/c Ratio	0.45	0.05	0.78	0.56	0.45	0.03
Uniform Delay, d1	4.8	3.5	6.7	5.3	17.4	15.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.0	12.2	0.3	0.9	0.0
Delay (s)	5.0	3.6	19.0	5.6	18.2	15.9
Level of Service	A	A	B	A	B	B
Approach Delay (s)	4.9			7.7	17.7	
Approach LOS	A			A	B	

Intersection Summary			
HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	50.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NBL	NBT	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1556	1770	3539	3539	1537
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1556	1770	3539	3539	1537
Volume (vph)	142	266	254	530	1107	93
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	154	289	276	576	1203	101
RTOR Reduction (vph)	0	238	0	0	0	40
Lane Group Flow (vph)	154	51	276	576	1203	61
Confl. Peds. (#/hr)	5	5	5			5
Turn Type		Perm	Prot			Perm
Protected Phases	6		7	4	8	
Permitted Phases		6				8
Actuated Green, G (s)	10.5	10.5	12.7	41.3	24.6	24.6
Effective Green, g (s)	10.5	10.5	12.7	41.3	24.6	24.6
Actuated g/C Ratio	0.18	0.18	0.21	0.69	0.41	0.41
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	311	273	376	2444	1456	632
v/s Ratio Prot	c0.09		c0.16	0.16	c0.34	
v/s Ratio Perm		0.03				0.04
v/c Ratio	0.50	0.19	0.73	0.24	0.83	0.10
Uniform Delay, d1	22.3	21.0	22.0	3.4	15.7	10.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.3	7.3	0.0	4.0	0.1
Delay (s)	23.5	21.3	29.2	3.5	19.7	10.9
Level of Service	C	C	C	A	B	B
Approach Delay (s)	22.1			11.8	19.0	
Approach LOS	C			B	B	

Intersection Summary			
HCM Average Control Delay	17.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	59.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	672	1200	42
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	730	1304	46
Pedestrians	5			5		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	0			0		
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1696	662	1355			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1696	662	1355			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	97	98			
cM capacity (veh/h)	81	401	502			

Direction, Lane #	SB 1	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	11	11	365	365	652	652	46
Volume Left	0	11	0	0	0	0	0
Volume Right	11	0	0	0	0	0	46
cSH	401	502	1700	1700	1700	1700	1700
Volume to Capacity	0.03	0.02	0.21	0.21	0.38	0.38	0.03
Queue Length 95th (ft)	2	2	0	0	0	0	0
Control Delay (s)	14.2	12.3	0.0	0.0	0.0	0.0	0.0
Lane LOS	B	B					
Approach Delay (s)	14.2	0.2			0.0		
Approach LOS	B						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	44.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	672	0	0	1242	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	730	0	0	1350	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1355			735			1415	2090	375	1725	2090	685
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1355			735			1415	2090	375	1725	2090	685
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	504			866			97	52	620	57	52	389

Direction, Lane #	EB 1	EB 2	WB 1	WB 2
Volume Total	365	365	675	675
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.21	0.21	0.40	0.40
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS				
Approach Delay (s)	0.0		0.0	
Approach LOS				

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	37.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	3433	1583	3539	1583	128	3539
Volume (vph)	180	84	2003	380	226	1870
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	91	2177	413	246	2033
RTOR Reduction (vph)	0	80	0	148	0	0
Lane Group Flow (vph)	196	11	2177	265	246	2033
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	10.1	10.1	54.0	54.0	66.0	66.0
Effective Green, g (s)	10.1	10.1	54.0	54.0	66.0	66.0
Actuated g/C Ratio	0.12	0.12	0.64	0.64	0.78	0.78
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	412	190	2272	1016	257	2777
v/s Ratio Prot	c0.06		0.62		c0.09	0.57
v/s Ratio Perm		0.01		0.17	c0.66	
v/c Ratio	0.48	0.06	0.96	0.26	0.96	0.73
Uniform Delay, d1	34.5	32.8	14.0	6.5	29.0	4.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	0.1	11.3	0.6	43.9	1.7
Delay (s)	35.4	32.9	25.3	7.1	72.9	6.3
Level of Service	D	C	C	A	E	A
Approach Delay (s)	34.6		22.4			13.5
Approach LOS	C		C			B

Intersection Summary			
HCM Average Control Delay	19.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	84.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.95	1.00	0.97	0.95
Frt	0.95	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3320	1441	3539	1583	3433	3539
Flt Permitted	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3320	1441	3539	1583	3433	3539
Volume (vph)	268	370	1940	189	302	1892
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	291	402	2109	205	328	2057
RTOR Reduction (vph)	80	139	0	81	0	0
Lane Group Flow (vph)	361	113	2109	124	328	2057
Turn Type		Perm		Perm	Prot	
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	13.9	13.9	53.1	53.1	9.0	66.1
Effective Green, g (s)	13.9	13.9	53.1	53.1	9.0	66.1
Actuated g/C Ratio	0.16	0.16	0.60	0.60	0.10	0.75
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	524	228	2135	955	351	2658
v/s Ratio Prot	c0.11		c0.60		c0.10	0.58
v/s Ratio Perm		0.08		0.08		
v/c Ratio	0.69	0.50	0.99	0.13	0.93	0.77
Uniform Delay, d1	35.0	33.8	17.1	7.5	39.2	6.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.8	1.7	16.8	0.3	31.4	2.3
Delay (s)	38.8	35.5	33.9	7.8	70.6	8.8
Level of Service	D	D	C	A	E	A
Approach Delay (s)	37.6		31.6			17.3
Approach LOS	D		C			B

Intersection Summary			
HCM Average Control Delay	26.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	88.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1496	489	17	2259	0	74
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1626	532	18	2455	0	80
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			2162		2486	546
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2162		2486	546
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		100	83
cM capacity (veh/h)			244		22	480

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1
Volume Total	542	542	542	532	18	818	818	818	80
Volume Left	0	0	0	0	18	0	0	0	0
Volume Right	0	0	0	532	0	0	0	0	80
cSH	1700	1700	1700	1700	244	1700	1700	1700	480
Volume to Capacity	0.32	0.32	0.32	0.31	0.08	0.48	0.48	0.48	0.17
Queue Length 95th (ft)	0	0	0	0	6	0	0	0	15
Control Delay (s)	0.0	0.0	0.0	0.0	21.0	0.0	0.0	0.0	14.0
Lane LOS					C				B
Approach Delay (s)	0.0				0.2				14.0
Approach LOS									B

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00	0.95	0.91	0.95	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	1770	3539	1583	1681	1618	1504	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	1770	3539	1583	1681	1618	1504	1770	1863	1583
Volume (vph)	366	1017	140	141	1305	94	487	10	378	130	10	460
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	398	1105	152	153	1418	102	529	11	411	141	11	500
RTOR Reduction (vph)	0	0	49	0	0	24	0	0	242	0	0	0
Lane Group Flow (vph)	398	1105	103	153	1418	78	269	271	169	141	11	500
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Free
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	12.1	35.8	35.8	16.3	40.0	40.0	16.0	16.0	16.0	12.4	12.4	96.5
Effective Green, g (s)	12.1	35.8	35.8	16.3	40.0	40.0	16.0	16.0	16.0	12.4	12.4	96.5
Actuated g/C Ratio	0.13	0.37	0.37	0.17	0.41	0.41	0.17	0.17	0.17	0.13	0.13	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	430	1313	587	299	1467	656	279	268	249	227	239	1583
v/s Ratio Prot	c0.12	0.31		0.09	c0.40		0.16	c0.17		c0.08	0.01	
v/s Ratio Perm			0.07			0.05			0.11			0.32
v/c Ratio	0.93	0.84	0.18	0.51	0.97	0.12	0.96	1.01	0.68	0.62	0.05	0.32
Uniform Delay, d1	41.8	27.8	20.4	36.5	27.6	17.4	40.0	40.2	37.8	39.8	36.9	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	25.7	5.1	0.1	1.5	16.1	0.1	43.8	57.9	7.2	5.2	0.1	0.5
Delay (s)	67.4	32.8	20.6	38.0	43.7	17.5	83.7	98.1	45.0	45.0	36.9	0.5
Level of Service	E	C	C	D	D	B	F	F	D	D	D	A
Approach Delay (s)		40.0			41.5			71.1			10.8	
Approach LOS		D			D			E			B	

Intersection Summary			
HCM Average Control Delay	42.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	96.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	84.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keohokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1555	3433	3539	1555	1770	1863	1555	3433	1863	1562
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1555	3433	3539	1555	1770	1863	1555	3433	1863	1562
Volume (vph)	389	873	277	282	559	259	113	251	380	342	297	449
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	423	949	301	307	608	282	123	273	413	372	323	488
RTOR Reduction (vph)	0	0	207	0	0	214	0	0	201	0	0	0
Lane Group Flow (vph)	423	949	94	307	608	68	123	273	212	372	323	488
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	12.0	20.9	20.9	7.1	16.0	16.0	7.6	13.7	13.7	9.1	15.2	66.8
Effective Green, g (s)	12.0	20.9	20.9	7.1	16.0	16.0	7.6	13.7	13.7	9.1	15.2	66.8
Actuated g/C Ratio	0.18	0.31	0.31	0.11	0.24	0.24	0.11	0.21	0.21	0.14	0.23	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	617	1107	487	365	848	372	201	382	319	468	424	1562
v/s Ratio Prot	c0.12	c0.27		0.09	0.17		0.07	0.15		c0.11	c0.17	
v/s Ratio Perm			0.06			0.04			0.14			c0.31
v/c Ratio	0.69	0.86	0.19	0.84	0.72	0.18	0.61	0.71	0.66	0.79	0.76	0.31
Uniform Delay, d1	25.6	21.5	16.8	29.3	23.3	20.2	28.2	24.7	24.4	27.9	24.1	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.2	6.7	0.2	15.9	2.9	0.2	5.4	6.2	5.1	9.0	7.9	0.5
Delay (s)	28.8	28.3	17.0	45.2	26.2	20.4	33.6	31.0	29.6	37.0	32.0	0.5
Level of Service	C	C	B	D	C	C	C	C	C	D	C	A
Approach Delay (s)		26.4			29.7			30.7			20.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	26.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	66.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
7: Hina Lani Street & Mamalahoa Highway

7/22/2011

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1583	1770	1863	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1583	1770	1863	3539	1583
Volume (vph)	683	554	363	850	635	452
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	742	602	395	924	690	491
RTOR Reduction (vph)	0	16	0	0	0	72
Lane Group Flow (vph)	742	586	395	924	690	419
Turn Type		pm+ov	Prot			pm+ov
Protected Phases	4	5	5	2	6	4
Permitted Phases		4				6
Actuated Green, G (s)	15.7	31.1	15.4	36.0	16.6	32.3
Effective Green, g (s)	15.7	31.1	15.4	36.0	16.6	32.3
Actuated g/C Ratio	0.26	0.52	0.26	0.60	0.28	0.54
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	903	931	457	1123	984	963
v/s Ratio Prot	c0.22	0.17	0.22	c0.50	0.19	0.13
v/s Ratio Perm		0.21				0.18
v/c Ratio	0.82	0.63	0.86	0.82	0.70	0.44
Uniform Delay, d1	20.7	10.2	21.2	9.3	19.3	8.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	6.1	1.3	15.5	6.9	4.2	0.3
Delay (s)	26.8	11.5	36.7	16.2	23.5	8.5
Level of Service	C	B	D	B	C	A
Approach Delay (s)	19.9			22.3	17.3	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	59.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	0.95	0.95	1.00	1.00	0.91	1.00	1.00	0.91	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected		0.96	1.00	0.95	0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1795	1583	1681	1690	1583	1770	5085	1583	1770	5073	
Flt Permitted		0.96	1.00	0.95	0.96	1.00	0.07	1.00	1.00	0.07	1.00	
Satd. Flow (perm)		1795	1583	1681	1690	1583	131	5085	1583	122	5073	
Volume (vph)	59	19	71	665	20	192	60	2225	460	143	2689	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	723	22	209	65	2418	500	155	2923	48
RTOR Reduction (vph)	0	0	3	0	0	146	0	0	252	0	1	0
Lane Group Flow (vph)	0	85	74	363	382	63	65	2418	248	155	2970	0
Turn Type	Split		Perm	Split		Perm	Perm		Perm	pm+pt		
Protected Phases	4	4		8	8			2		1	6	
Permitted Phases			4			8	2		2	6		
Actuated Green, G (s)		10.8	10.8	25.0	25.0	25.0	57.0	57.0	57.0	67.0	67.0	
Effective Green, g (s)		10.8	10.8	25.0	25.0	25.0	57.0	57.0	57.0	67.0	67.0	
Actuated g/C Ratio		0.09	0.09	0.22	0.22	0.22	0.50	0.50	0.50	0.58	0.58	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		169	149	366	368	345	65	2525	786	157	2961	
v/s Ratio Prot		c0.05		0.22	c0.23			0.48		0.05	c0.59	
v/s Ratio Perm			0.05			0.04	0.50		0.16	0.52		
v/c Ratio		0.50	0.50	0.99	1.04	0.18	1.00	0.96	0.32	0.99	1.00	
Uniform Delay, d1		49.4	49.4	44.8	44.9	36.6	28.9	27.7	17.3	32.0	23.9	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		2.3	2.6	44.7	57.1	0.3	111.6	10.4	1.1	67.4	17.2	
Delay (s)		51.8	52.0	89.5	102.0	36.8	140.5	38.2	18.3	99.4	41.1	
Level of Service		D	D	F	F	D	F	D	B	F	D	
Approach Delay (s)		51.9			83.0			37.1			44.0	
Approach LOS		D			F			D			D	

Intersection Summary				
HCM Average Control Delay	46.5	HCM Level of Service	D	
HCM Volume to Capacity ratio	0.96			
Actuated Cycle Length (s)	114.8	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	91.9%	ICU Level of Service	F	
Analysis Period (min)	15			
c Critical Lane Group				

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	172	1353	1354	36	0	186
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	187	1471	1472	39	0	202
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					TWLTL	
Median storage veh)					3	
Upstream signal (ft)			1250			
pX, platoon unblocked	0.84				0.84	0.84
vC, conflicting volume	1516				2591	746
vC1, stage 1 conf vol					1477	
vC2, stage 2 conf vol					1114	
vCu, unblocked vol	1425				2703	509
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)	2.2				3.5	3.3
p0 queue free %	53				100	52
cM capacity (veh/h)	397				117	425

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	SB 1
Volume Total	187	735	735	736	736	39	202
Volume Left	187	0	0	0	0	0	0
Volume Right	0	0	0	0	0	39	202
cSH	397	1700	1700	1700	1700	1700	425
Volume to Capacity	0.47	0.43	0.43	0.43	0.43	0.02	0.48
Queue Length 95th (ft)	61	0	0	0	0	0	63
Control Delay (s)	21.9	0.0	0.0	0.0	0.0	0.0	20.9
Lane LOS	C						C
Approach Delay (s)	2.5			0.0			20.9
Approach LOS							C

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	61.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frpb, ped/bikes	1.00	0.97	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1540	1768	3539	1770	1557
Flt Permitted	1.00	1.00	0.15	1.00	0.95	1.00
Satd. Flow (perm)	3539	1540	282	3539	1770	1557
Volume (vph)	1334	18	55	1065	325	205
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1450	20	60	1158	353	223
RTOR Reduction (vph)	0	9	0	0	0	24
Lane Group Flow (vph)	1450	11	60	1158	353	199
Confl. Peds. (#/hr)		5	5		5	5
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	26.4	26.4	26.4	26.4	13.8	13.8
Effective Green, g (s)	26.4	26.4	26.4	26.4	13.8	13.8
Actuated g/C Ratio	0.55	0.55	0.55	0.55	0.29	0.29
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1938	843	154	1938	507	446
v/s Ratio Prot	c0.41			0.33	c0.20	
v/s Ratio Perm		0.01	0.21			0.13
v/c Ratio	0.75	0.01	0.39	0.60	0.70	0.45
Uniform Delay, d1	8.4	5.0	6.3	7.3	15.3	14.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.6	0.0	1.6	0.5	4.1	0.7
Delay (s)	10.0	5.0	7.9	7.8	19.5	14.8
Level of Service	A	A	A	A	B	B
Approach Delay (s)	9.9			7.8	17.7	
Approach LOS	A			A	B	

Intersection Summary			
HCM Average Control Delay	10.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	48.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NBL	NBT	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1557	1770	3539	3539	1539
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1557	1770	3539	3539	1539
Volume (vph)	163	306	293	1303	794	107
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	177	333	318	1416	863	116
RTOR Reduction (vph)	0	264	0	0	0	75
Lane Group Flow (vph)	177	69	318	1416	863	41
Confl. Peds. (#/hr)	5	5	5			5
Turn Type		Perm	Prot			Perm
Protected Phases	6		7	4	8	
Permitted Phases		6				8
Actuated Green, G (s)	10.6	10.6	12.6	32.8	16.2	16.2
Effective Green, g (s)	10.6	10.6	12.6	32.8	16.2	16.2
Actuated g/C Ratio	0.21	0.21	0.25	0.64	0.32	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	365	321	434	2258	1115	485
v/s Ratio Prot	c0.10		0.18	c0.40	c0.24	
v/s Ratio Perm		0.04				0.03
v/c Ratio	0.48	0.21	0.73	0.63	0.77	0.08
Uniform Delay, d1	18.0	16.9	17.9	5.6	15.9	12.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.0	0.3	6.3	0.6	3.4	0.1
Delay (s)	19.0	17.3	24.1	6.2	19.4	12.5
Level of Service	B	B	C	A	B	B
Approach Delay (s)	17.9			9.5	18.5	
Approach LOS	B			A	B	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	51.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	57.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	1466	901	49
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	1593	979	53
Pedestrians	5			5		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	0			0		
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1803	500	1038			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1803	500	1038			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	98	98			
cM capacity (veh/h)	69	512	663			

Direction, Lane #	SB 1	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	11	11	797	797	490	490	53
Volume Left	0	11	0	0	0	0	0
Volume Right	11	0	0	0	0	0	53
cSH	512	663	1700	1700	1700	1700	1700
Volume to Capacity	0.02	0.02	0.47	0.47	0.29	0.29	0.03
Queue Length 95th (ft)	2	1	0	0	0	0	0
Control Delay (s)	12.2	10.5	0.0	0.0	0.0	0.0	0.0
Lane LOS	B	B					
Approach Delay (s)	12.2	0.1			0.0		
Approach LOS	B						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	52.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	1466	0	0	950	0	0	0	0	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	1593	0	0	1033	0	0	0	0	0	0	0
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			0.0			0.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1038			1598			2120	2636	807	1839	2636	526
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1038			1598			2120	2636	807	1839	2636	526
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	100	100	100	100
cM capacity (veh/h)	666			406			28	23	323	47	23	494

Direction, Lane #	EB 1	EB 2	WB 1	WB 2
Volume Total	797	797	516	516
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.47	0.47	0.30	0.30
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS				
Approach Delay (s)	0.0		0.0	
Approach LOS				

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	43.9%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix L - Intersection Operations Analysis Worksheets for 2035 With Project Phase 3 Conditions, with Existing Geometry

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.10	1.00
Satd. Flow (perm)	1770	1583	1863	1583	187	1863
Volume (vph)	480	244	1966	102	33	1944
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	265	2137	111	36	2113
RTOR Reduction (vph)	0	16	0	30	0	0
Lane Group Flow (vph)	522	249	2137	81	36	2113
Turn Type		Perm		Perm	Perm	
Protected Phases	8		2			6
Permitted Phases		8		2	6	
Actuated Green, G (s)	33.0	33.0	109.0	109.0	109.0	109.0
Effective Green, g (s)	33.0	33.0	109.0	109.0	109.0	109.0
Actuated g/C Ratio	0.22	0.22	0.73	0.73	0.73	0.73
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	389	348	1354	1150	136	1354
v/s Ratio Prot	c0.29		c1.15			1.13
v/s Ratio Perm		0.16		0.05	0.19	
v/c Ratio	1.34	0.72	1.58	0.07	0.26	1.56
Uniform Delay, d1	58.5	54.2	20.5	5.9	6.9	20.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	170.3	6.9	263.8	0.1	4.7	255.9
Delay (s)	228.8	61.0	284.3	6.0	11.6	276.4
Level of Service	F	E	F	A	B	F
Approach Delay (s)	172.3		270.6			272.0
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	256.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.52		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	136.7%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	212	347	1750	289	378	1948
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	230	377	1902	314	411	2117
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	4841	1902			1902	
vC1, stage 1 conf vol	1902					
vC2, stage 2 conf vol	2939					
vCu, unblocked vol	4841	1902			1902	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	0			0	
cM capacity (veh/h)	0	86			312	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	608	1902	314	411	2117
Volume Left	230	0	0	411	0
Volume Right	377	0	314	0	0
cSH	0	1700	1700	312	1700
Volume to Capacity	Err	1.12	0.18	1.31	1.25
Queue Length 95th (ft)	Err	0	0	500	0
Control Delay (s)	Err	0.0	0.0	196.2	0.0
Lane LOS	F			F	
Approach Delay (s)	Err	0.0		31.9	
Approach LOS	F				

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	134.8%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.95	1.00	0.94	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1503	1863	1493	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	1770	1503	1863	1493	126	1863
Volume (vph)	1156	750	1229	1464	866	1376
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1257	815	1336	1591	941	1496
RTOR Reduction (vph)	0	171	0	434	0	0
Lane Group Flow (vph)	1257	644	1336	1157	941	1496
Confl. Peds. (#/hr)		14		8	8	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	52.0	52.0	55.0	55.0	90.0	90.0
Effective Green, g (s)	52.0	52.0	55.0	55.0	90.0	90.0
Actuated g/C Ratio	0.35	0.35	0.37	0.37	0.60	0.60
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	614	521	683	547	415	1118
v/s Ratio Prot	c0.71		0.72		c0.47	0.80
v/s Ratio Perm		0.43		0.77	c0.89	
v/c Ratio	2.05	1.24	1.96	2.12	2.27	1.34
Uniform Delay, d1	49.0	49.0	47.5	47.5	61.7	30.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	476.9	121.9	435.6	508.1	578.0	158.3
Delay (s)	525.9	170.9	483.1	555.6	639.7	188.3
Level of Service	F	F	F	F	F	F
Approach Delay (s)	386.3		522.5			362.6
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	432.1	HCM Level of Service	F
HCM Volume to Capacity ratio	2.16		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	186.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations		↑	↱		↰↑↑		↱
Sign Control		Free			Free	Stop	
Grade		0%			0%	0%	
Volume (veh/h)		1935	363	29	1925	0	18
Peak Hour Factor		0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)		2103	395	32	2092	0	20
Pedestrians						2	
Lane Width (ft)						12.0	
Walking Speed (ft/s)						4.0	
Percent Blockage						0	
Right turn flare (veh)							
Median type						None	
Median storage veh)							
Upstream signal (ft)		475					
pX, platoon unblocked							
vC, conflicting volume				2500		3214	2105
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol				2500		3214	2105
tC, single (s)				4.1		6.8	6.9
tC, 2 stage (s)							
tF (s)				2.2		3.5	3.3
p0 queue free %				82		100	54
cM capacity (veh/h)				179		6	42

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	2103	395	729	1395	20
Volume Left	0	0	32	0	0
Volume Right	0	395	0	0	20
cSH	1700	1700	179	1700	42
Volume to Capacity	1.24	0.23	0.18	0.82	0.46
Queue Length 95th (ft)	0	0	15	0	41
Control Delay (s)	0.0	0.0	9.6	0.0	148.5
Lane LOS			A		F
Approach Delay (s)	0.0		3.3		148.5
Approach LOS					F

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	111.8%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱	↰	↰↑			↰↑	↱		↰↑	↱
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	430	1246	264	255	1335	126	291	10	88	87	10	337
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	467	1354	287	277	1451	137	316	11	96	95	11	366
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1588			1354			4483	4432	1354	4416	4363	1520
vC1, stage 1 conf vol							2289	2289				
vC2, stage 2 conf vol							2194	2142				
vCu, unblocked vol	1588			1354			4483	4432	1354	4416	4363	1520
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	0			45			0	0	48	0	0	0
cM capacity (veh/h)	413			508			0	0	183	0	0	146

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	1822	287	277	1588	423	472
Volume Left	467	0	277	0	316	95
Volume Right	0	287	0	137	96	366
cSH	413	1700	508	1700	0	0
Volume to Capacity	1.13	0.17	0.55	0.93	Err	Err
Queue Length 95th (ft)	426	0	81	0	Err	Err
Control Delay (s)	453.5	0.0	20.3	0.0	Err	Err
Lane LOS	F		C		F	F
Approach Delay (s)	391.8		3.0		Err	Err
Approach LOS					F	F

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	200.6%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keohokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	502	544	124	348	1020	342	296	335	186	253	251	339
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	546	591	135	378	1109	372	322	364	202	275	273	368
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1485			731			3878	3930	601	3841	3693	1119
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1485			731			3878	3930	601	3841	3693	1119
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	0			57			0	0	59	0	0	0
cM capacity (veh/h)	451			870			0	0	496	0	0	250

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	546	591	135	378	1109	372	322	566	275	641
Volume Left	546	0	0	378	0	0	322	0	275	0
Volume Right	0	0	135	0	0	372	0	202	0	368
cSH	451	1700	1700	870	1700	1700	0	0	0	0
Volume to Capacity	1.21	0.35	0.08	0.43	0.65	0.22	Err	Err	Err	Err
Queue Length 95th (ft)	535	0	0	56	0	0	Err	Err	Err	Err
Control Delay (s)	141.6	0.0	0.0	12.3	0.0	0.0	Err	Err	Err	Err
Lane LOS	F			B			F	F	F	F
Approach Delay (s)	60.8			2.5			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	126.5%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
7: Hina Lani Street & Mamalahoa Highway

6/24/2011

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.10	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	179	1863	1863	1583
Volume (vph)	389	400	497	568	1970	600
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	423	435	540	617	2141	652
RTOR Reduction (vph)	0	144	0	0	0	37
Lane Group Flow (vph)	423	291	540	617	2141	615
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	26.0	26.0	116.0	116.0	95.0	95.0
Effective Green, g (s)	26.0	26.0	116.0	116.0	95.0	95.0
Actuated g/C Ratio	0.17	0.17	0.77	0.77	0.63	0.63
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	307	274	319	1441	1180	1003
v/s Ratio Prot	c0.24		c0.19	0.33	c1.15	
v/s Ratio Perm		0.18	1.12			0.39
v/c Ratio	1.38	1.06	1.69	0.43	1.81	0.61
Uniform Delay, d1	62.0	62.0	33.2	5.8	27.5	16.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	189.2	71.9	325.0	0.9	369.9	2.8
Delay (s)	251.2	133.9	358.1	6.7	397.4	19.3
Level of Service	F	F	F	A	F	B
Approach Delay (s)	191.7			170.7	309.1	
Approach LOS	F			F	F	

Intersection Summary			
HCM Average Control Delay	254.9	HCM Level of Service	F
HCM Volume to Capacity ratio	1.72		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	162.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1800	1583		1777	1583	1770	1863	1549	1770	1863	1549
Flt Permitted		0.39	1.00		0.71	1.00	0.09	1.00	1.00	0.05	1.00	1.00
Satd. Flow (perm)		718	1583		1331	1583	162	1863	1549	93	1863	1549
Volume (vph)	17	7	24	491	18	166	68	2571	723	240	2103	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	534	20	180	74	2795	786	261	2286	52
RTOR Reduction (vph)	0	0	19	0	0	39	0	0	155	0	0	12
Lane Group Flow (vph)	0	26	7	0	554	141	74	2795	631	261	2286	40
Confl. Peds. (#/hr)							2		2	2		2
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		39.0	39.0		39.0	39.0	94.0	90.0	90.0	103.0	95.0	95.0
Effective Green, g (s)		39.0	39.0		39.0	39.0	94.0	90.0	90.0	103.0	95.0	95.0
Actuated g/C Ratio		0.26	0.26		0.26	0.26	0.63	0.60	0.60	0.69	0.63	0.63
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		187	412		346	412	144	1118	929	164	1180	981
v/s Ratio Prot							0.01	c1.50		c0.10	1.23	
v/s Ratio Perm		0.04	0.00		c0.42	0.09	0.31		0.41	0.99		0.03
v/c Ratio		0.14	0.02		1.60	0.34	0.51	2.50	0.68	1.59	1.94	0.04
Uniform Delay, d1		42.6	41.2		55.5	45.1	10.9	30.0	20.2	36.2	27.5	10.3
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		0.3	0.0		283.7	0.5	3.1	677.7	4.0	293.0	424.9	0.1
Delay (s)		43.0	41.3		339.2	45.6	14.0	707.7	24.2	329.1	452.4	10.4
Level of Service		D	D		F	D	B	F	C	F	F	B
Approach Delay (s)		42.1			267.2			546.7			431.2	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM Average Control Delay	471.2	HCM Level of Service	F
HCM Volume to Capacity ratio	2.19		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	193.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	215	1205	1569	29	0	147
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	234	1310	1705	32	0	160
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1742				3493	1715
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1742				3493	1715
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	35				100	0
cM capacity (veh/h)	359				2	111

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	234	1310	1705	32	160
Volume Left	234	0	0	0	0
Volume Right	0	0	0	32	160
cSH	359	1700	1700	1700	111
Volume to Capacity	0.65	0.77	1.00	0.02	1.45
Queue Length 95th (ft)	109	0	0	0	285
Control Delay (s)	31.9	0.0	0.0	0.0	314.4
Lane LOS	D				F
Approach Delay (s)	4.8		0.0		314.4
Approach LOS					F

Intersection Summary			
Average Delay	16.8		
Intersection Capacity Utilization	109.4%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1067	138	251	1405	194	103
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1160	150	273	1527	211	112
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1315		3243	1170
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1315		3243	1170
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			48		0	52
cM capacity (veh/h)			524		5	233

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1160	150	273	1527	323
Volume Left	0	0	273	0	211
Volume Right	0	150	0	0	112
cSH	1700	1700	524	1700	8
Volume to Capacity	0.68	0.09	0.52	0.90	43.04
Queue Length 95th (ft)	0	0	74	0	Err
Control Delay (s)	0.0	0.0	19.1	0.0	Err
Lane LOS			C		F
Approach Delay (s)	0.0		2.9		Err
Approach LOS					F

Intersection Summary			
Average Delay	941.9		
Intersection Capacity Utilization	91.8%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	142	266	254	730	1444	93
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	154	289	276	793	1570	101
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2925	1580	1676			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2925	1580	1676			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	0	28			
cM capacity (veh/h)	5	133	381			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	154	289	276	793	1570	101
Volume Left	154	0	276	0	0	0
Volume Right	0	289	0	0	0	101
cSH	5	133	381	1700	1700	1700
Volume to Capacity	33.61	2.17	0.72	0.47	0.92	0.06
Queue Length 95th (ft)	Err	600	139	0	0	0
Control Delay (s)	Err	603.8	35.7	0.0	0.0	0.0
Lane LOS	F	F	E			
Approach Delay (s)	3873.7		9.2		0.0	
Approach LOS	F					

Intersection Summary			
Average Delay	542.7		
Intersection Capacity Utilization	108.8%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	872	1537	42
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	948	1671	46
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2650	1681	1721			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2650	1681	1721			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	91	97			
cM capacity (veh/h)	24	116	366			

Direction, Lane #	SB 1	NE 1	NE 2	SW 1	SW 2
Volume Total	11	11	948	1671	46
Volume Left	0	11	0	0	0
Volume Right	11	0	0	0	46
cSH	116	366	1700	1700	1700
Volume to Capacity	0.09	0.03	0.56	0.98	0.03
Queue Length 95th (ft)	8	2	0	0	0
Control Delay (s)	39.2	15.1	0.0	0.0	0.0
Lane LOS	E	C			
Approach Delay (s)	39.2	0.2		0.0	
Approach LOS	E				

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	92.4%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	18	706	149	42	1265	8	258	17	73	26	10	56
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	767	162	46	1375	9	280	18	79	28	11	61
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1389			934			2349	2292	777	2371	2445	1385
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1389			934			2349	2292	777	2371	2445	1385
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			94			0	47	80	0	61	65
cM capacity (veh/h)	491			730			10	35	393	10	28	174

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	20	767	162	46	1375	9	280	98	28	72
Volume Left	20	0	0	46	0	0	280	0	28	0
Volume Right	0	0	162	0	0	9	0	79	0	61
cSH	491	1700	1700	730	1700	1700	10	134	10	97
Volume to Capacity	0.04	0.45	0.10	0.06	0.81	0.01	26.97	0.73	2.74	0.74
Queue Length 95th (ft)	3	0	0	5	0	0	Err	105	114	96
Control Delay (s)	12.6	0.0	0.0	10.3	0.0	0.0	Err	83.1	1508.2	109.2
Lane LOS	B			B			F	F	F	F
Approach Delay (s)	0.3			0.3			7434.5		504.6	
Approach LOS							F		F	

Intersection Summary			
Average Delay	1002.4		
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Kaiminani Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	1770	1583	1863	1583	118	1863
Volume (vph)	180	84	2362	380	226	2342
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	91	2567	413	246	2546
RTOR Reduction (vph)	0	72	0	96	0	0
Lane Group Flow (vph)	196	19	2567	317	246	2546
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	16.0	16.0	114.0	114.0	126.0	126.0
Effective Green, g (s)	16.0	16.0	114.0	114.0	126.0	126.0
Actuated g/C Ratio	0.11	0.11	0.76	0.76	0.84	0.84
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	189	169	1416	1203	187	1565
v/s Ratio Prot	c0.11		c1.38		0.07	c1.37
v/s Ratio Perm		0.01		0.20	1.03	
v/c Ratio	1.04	0.11	1.81	0.26	1.32	1.63
Uniform Delay, d1	67.0	60.6	18.0	5.4	28.8	12.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	75.5	0.3	368.6	0.5	174.6	285.0
Delay (s)	142.5	60.9	386.6	5.9	203.4	297.0
Level of Service	F	E	F	A	F	F
Approach Delay (s)	116.6		333.8			288.8
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	302.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.73		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	156.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
2: Hulikoa Drive & Queen Kaahumanu Highway

6/24/2011

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	271	385	2284	196	326	2341
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	295	418	2483	213	354	2545
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)		20				
Median type	TWLTL					
Median storage veh)	5					
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	5736	2483			2483	
vC1, stage 1 conf vol	2483					
vC2, stage 2 conf vol	3253					
vCu, unblocked vol	5736	2483			2483	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	0			0	
cM capacity (veh/h)	0	38			185	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	713	2483	213	354	2545
Volume Left	295	0	0	354	0
Volume Right	418	0	213	0	0
cSH	0	1700	1700	185	1700
Volume to Capacity	Err	1.46	0.13	1.92	1.50
Queue Length 95th (ft)	Err	0	0	656	0
Control Delay (s)	Err	0.0	0.0	474.0	0.0
Lane LOS	F			F	
Approach Delay (s)	Err	0.0		57.9	
Approach LOS	F				

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	163.3%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.93	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1477	1863	1544	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	1770	1477	1863	1544	124	1863
Volume (vph)	1601	1013	1542	1585	833	1686
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1740	1101	1676	1723	905	1833
RTOR Reduction (vph)	0	167	0	484	0	0
Lane Group Flow (vph)	1740	934	1676	1239	905	1833
Confl. Peds. (#/hr)		20		1	1	
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	58.0	58.0	56.0	56.0	84.0	84.0
Effective Green, g (s)	58.0	58.0	56.0	56.0	84.0	84.0
Actuated g/C Ratio	0.39	0.39	0.37	0.37	0.56	0.56
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	684	571	696	576	333	1043
v/s Ratio Prot	c0.98		0.90		c0.44	0.98
v/s Ratio Perm		0.63		0.80	c1.09	
v/c Ratio	2.54	1.64	2.41	2.15	2.72	1.76
Uniform Delay, d1	46.0	46.0	47.0	47.0	65.2	33.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	699.0	294.1	638.0	523.9	781.4	344.8
Delay (s)	745.0	340.1	685.0	570.9	846.6	377.8
Level of Service	F	F	F	F	F	F
Approach Delay (s)	588.1		627.2			532.8
Approach LOS	F		F			F

Intersection Summary			
HCM Average Control Delay	586.0	HCM Level of Service	F
HCM Volume to Capacity ratio	2.62		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	226.0%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1880	489	17	2525	0	74
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2043	532	18	2745	0	80
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)	475					
pX, platoon unblocked						
vC, conflicting volume			2579		3457	2047
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2579		3457	2047
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			89		100	0
cM capacity (veh/h)			166		4	46

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	2043	532	933	1830	80
Volume Left	0	0	18	0	0
Volume Right	0	532	0	0	80
cSH	1700	1700	166	1700	46
Volume to Capacity	1.20	0.31	0.11	1.08	1.73
Queue Length 95th (ft)	0	0	9	0	200
Control Delay (s)	0.0	0.0	7.5	0.0	543.2
Lane LOS			A		F
Approach Delay (s)	0.0		2.5		543.2
Approach LOS					F

Intersection Summary			
Average Delay	9.4		
Intersection Capacity Utilization	110.2%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
5: Hina Lani Street & Kamanu Street

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	366	1400	140	141	1509	94	550	10	378	130	10	460
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	398	1522	152	153	1640	102	598	11	411	141	11	500
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)									14			8
Median type								TWLTL			None	
Median storage veh)								5				
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1742			1522			4520	4366	1522	4526	4315	1691
vC1, stage 1 conf vol							2317	2317				
vC2, stage 2 conf vol							2202	2049				
vCu, unblocked vol	1742			1522			4520	4366	1522	4526	4315	1691
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5				
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	0			65			0	0	0	0	0	0
cM capacity (veh/h)	360			438			0	0	146	0	0	115

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	1920	152	153	1742	1020	652
Volume Left	398	0	153	0	598	141
Volume Right	0	152	0	102	411	500
cSH	360	1700	438	1700	0	0
Volume to Capacity	1.10	0.09	0.35	1.02	Err	Err
Queue Length 95th (ft)	369	0	39	0	Err	Err
Control Delay (s)	874.4	0.0	17.6	0.0	Err	Err
Lane LOS	F		C		F	F
Approach Delay (s)	810.2		1.4		Err	Err
Approach LOS					F	F

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	226.7%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keahokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	411	1146	306	325	751	259	147	273	449	342	317	461
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	447	1246	333	353	816	282	160	297	488	372	345	501
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)									12			12
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1103			1583			4095	3953	1256	4064	4005	826
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1103			1583			4095	3953	1256	4064	4005	826
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	29			15			0	0	0	0	0	0
cM capacity (veh/h)	630			413			0	0	207	0	0	369

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	447	1246	333	353	816	282	160	785	372	846
Volume Left	447	0	0	353	0	0	160	0	372	0
Volume Right	0	0	333	0	0	282	0	488	0	501
cSH	630	1700	1700	413	1700	1700	0	0	0	0
Volume to Capacity	0.71	0.73	0.20	0.85	0.48	0.17	Err	2273.96	Err	2859.84
Queue Length 95th (ft)	146	0	0	209	0	0	Err	Err	Err	Err
Control Delay (s)	23.4	0.0	0.0	47.5	0.0	0.0	Err	Err	Err	Err
Lane LOS	C			E			F	F	F	F
Approach Delay (s)	5.2			11.6			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	125.0%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	1863	1863	1583
Flt Permitted	0.95	1.00	0.07	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	126	1863	1863	1583
Volume (vph)	729	604	437	1095	823	519
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	792	657	475	1190	895	564
RTOR Reduction (vph)	0	235	0	0	0	81
Lane Group Flow (vph)	792	422	475	1190	895	483
Turn Type		Perm	pm+pt			Perm
Protected Phases	4		5	2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	49.0	49.0	83.0	83.0	55.0	55.0
Effective Green, g (s)	49.0	49.0	83.0	83.0	55.0	55.0
Actuated g/C Ratio	0.35	0.35	0.59	0.59	0.39	0.39
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	620	554	357	1104	732	622
v/s Ratio Prot	c0.45		c0.23	0.64	0.48	
v/s Ratio Perm		0.27	c0.56			0.31
v/c Ratio	1.28	0.76	1.33	1.08	1.22	0.78
Uniform Delay, d1	45.5	40.3	60.2	28.5	42.5	37.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	137.0	6.2	166.8	50.7	112.3	9.2
Delay (s)	182.5	46.5	227.0	79.2	154.8	46.4
Level of Service	F	D	F	E	F	D
Approach Delay (s)	120.8			121.3	112.9	
Approach LOS	F			F	F	

Intersection Summary			
HCM Average Control Delay	118.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.30		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	117.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.96	1.00		0.95	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1795	1583		1776	1583	1770	1863	1583	1770	1863	1583
Flt Permitted		0.12	1.00		0.66	1.00	0.05	1.00	1.00	0.05	1.00	1.00
Satd. Flow (perm)		232	1583		1227	1583	91	1863	1583	90	1863	1583
Volume (vph)	59	19	71	702	20	192	60	2704	514	143	3154	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	763	22	209	65	2939	559	155	3428	48
RTOR Reduction (vph)	0	0	34	0	0	32	0	0	105	0	0	8
Lane Group Flow (vph)	0	85	43	0	785	177	65	2939	454	155	3428	40
Turn Type	Perm		Perm	Perm		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		51.0	51.0		51.0	51.0	86.0	82.0	82.0	88.0	83.0	83.0
Effective Green, g (s)		51.0	51.0		51.0	51.0	86.0	82.0	82.0	88.0	83.0	83.0
Actuated g/C Ratio		0.34	0.34		0.34	0.34	0.57	0.55	0.55	0.59	0.55	0.55
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		79	538		417	538	97	1018	865	109	1031	876
v/s Ratio Prot							0.02	1.58		c0.05	c1.84	
v/s Ratio Perm		0.37	0.03		c0.64	0.11	0.37		0.29	0.79		0.03
v/c Ratio		1.08	0.08		1.88	0.33	0.67	2.89	0.52	1.42	3.32	0.05
Uniform Delay, d1		49.5	33.6		49.5	36.8	14.2	34.0	21.6	24.4	33.5	15.4
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		123.5	0.1		406.1	0.4	16.7	851.9	2.3	234.9	1048.7	0.1
Delay (s)		173.0	33.7		455.6	37.2	30.8	885.9	23.9	259.3	1082.2	15.5
Level of Service		F	C		F	D	C	F	C	F	F	B
Approach Delay (s)		106.8			367.6			735.0			1033.0	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM Average Control Delay	808.7	HCM Level of Service	F
HCM Volume to Capacity ratio	2.67		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	220.3%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	172	1736	1558	36	0	186
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	187	1887	1693	39	0	202
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1738				3964	1703
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1738				3964	1703
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	48				100	0
cM capacity (veh/h)	360				2	112

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1
Volume Total	187	1887	1693	39	202
Volume Left	187	0	0	0	0
Volume Right	0	0	0	39	202
cSH	360	1700	1700	1700	112
Volume to Capacity	0.52	1.11	1.00	0.02	1.80
Queue Length 95th (ft)	71	0	0	0	399
Control Delay (s)	25.3	0.0	0.0	0.0	458.0
Lane LOS	D				F
Approach Delay (s)	2.3		0.0		458.0
Approach LOS					F

Intersection Summary			
Average Delay	24.3		
Intersection Capacity Utilization	106.4%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1594	142	130	1228	367	269
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1733	154	141	1335	399	292
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						4
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			1892		3360	1743
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1892		3360	1743
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			55		0	0
cM capacity (veh/h)			314		5	106

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	1733	154	141	1335	691
Volume Left	0	0	141	0	399
Volume Right	0	154	0	0	292
cSH	1700	1700	314	1700	8
Volume to Capacity	1.02	0.09	0.45	0.79	86.58
Queue Length 95th (ft)	0	0	56	0	Err
Control Delay (s)	0.0	0.0	25.5	0.0	Err
Lane LOS			D		F
Approach Delay (s)	0.0		2.4		Err
Approach LOS					F

Intersection Summary			
Average Delay	1705.8		
Intersection Capacity Utilization	121.4%	ICU Level of Service	H
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	163	306	293	1644	1030	107
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	177	333	318	1787	1120	116
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3553	1130	1241			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3553	1130	1241			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	0	43			
cM capacity (veh/h)	3	246	559			

Direction, Lane #	SB 1	SB 2	NE 1	NE 2	SW 1	SW 2
Volume Total	177	333	318	1787	1120	116
Volume Left	177	0	318	0	0	0
Volume Right	0	333	0	0	0	116
cSH	3	246	559	1700	1700	1700
Volume to Capacity	64.01	1.35	0.57	1.05	0.66	0.07
Queue Length 95th (ft)	Err	446	89	0	0	0
Control Delay (s)	Err	222.2	19.6	0.0	0.0	0.0
Lane LOS	F	F	C			
Approach Delay (s)	3620.1		3.0		0.0	
Approach LOS	F					

Intersection Summary			
Average Delay	480.8		
Intersection Capacity Utilization	102.9%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	1807	1137	49
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	1964	1236	53
Pedestrians	5			5	5	
Lane Width (ft)	12.0			12.0	12.0	
Walking Speed (ft/s)	4.0			4.0	4.0	
Percent Blockage	0			0	0	
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3232	1246	1294			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3232	1246	1294			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	95	98			
cM capacity (veh/h)	10	210	533			

Direction, Lane #	SB 1	NE 1	NE 2	SW 1	SW 2
Volume Total	11	11	1964	1236	53
Volume Left	0	11	0	0	0
Volume Right	11	0	0	0	53
cSH	210	533	1700	1700	1700
Volume to Capacity	0.05	0.02	1.16	0.73	0.03
Queue Length 95th (ft)	4	2	0	0	0
Control Delay (s)	23.1	11.9	0.0	0.0	0.0
Lane LOS	C	B			
Approach Delay (s)	23.1	0.1		0.0	
Approach LOS	C				

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	106.6%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	62	1501	244	69	992	29	161	11	46	16	16	34
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	67	1632	265	75	1078	32	175	12	50	17	17	37
Pedestrians		5			5			5			5	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1115			1902			3050	3036	1642	3061	3270	1088
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1115			1902			3050	3036	1642	3061	3270	1088
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	89			76			0	0	59	0	0	86
cM capacity (veh/h)	624			311			0	9	122	0	6	260

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	67	1632	265	75	1078	32	175	62	17	54
Volume Left	67	0	0	75	0	0	175	0	17	0
Volume Right	0	0	265	0	0	32	0	50	0	37
cSH	624	1700	1700	311	1700	1700	0	35	0	18
Volume to Capacity	0.11	0.96	0.16	0.24	0.63	0.02	Err	1.79	Err	3.02
Queue Length 95th (ft)	9	0	0	23	0	0	Err	171	Err	Err
Control Delay (s)	11.5	0.0	0.0	20.2	0.0	0.0	Err	628.2	Err	Err
Lane LOS	B			C			F	F	F	F
Approach Delay (s)	0.4			1.3			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	101.3%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.06	1.00
Satd. Flow (perm)	3433	1583	3539	1583	114	3539
Volume (vph)	480	244	1966	102	33	1944
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	522	265	2137	111	36	2113
RTOR Reduction (vph)	0	67	0	37	0	0
Lane Group Flow (vph)	522	198	2137	74	36	2113
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	15.7	15.7	61.2	61.2	67.6	67.6
Effective Green, g (s)	15.7	15.7	61.2	61.2	67.6	67.6
Actuated g/C Ratio	0.17	0.17	0.67	0.67	0.74	0.74
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	590	272	2372	1061	128	2620
v/s Ratio Prot	c0.15		c0.60		0.01	c0.60
v/s Ratio Perm		0.13		0.05	0.20	
v/c Ratio	0.88	0.73	0.90	0.07	0.28	0.81
Uniform Delay, d1	36.9	35.8	12.5	5.2	18.0	7.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.7	9.3	6.1	0.1	1.2	2.8
Delay (s)	51.7	45.1	18.6	5.3	19.2	10.4
Level of Service	D	D	B	A	B	B
Approach Delay (s)	49.4		17.9			10.6
Approach LOS	D		B			B

Intersection Summary			
HCM Average Control Delay	19.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	91.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.95	1.00	0.97	0.95
Frt	0.94	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3296	1441	3539	1583	3433	3539
Flt Permitted	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3296	1441	3539	1583	3433	3539
Volume (vph)	212	347	1750	289	378	1948
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	230	377	1902	314	411	2117
RTOR Reduction (vph)	135	174	0	127	0	0
Lane Group Flow (vph)	251	47	1902	187	411	2117
Turn Type		Perm		Perm	Prot	
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	11.8	11.8	51.1	51.1	11.0	66.1
Effective Green, g (s)	11.8	11.8	51.1	51.1	11.0	66.1
Actuated g/C Ratio	0.14	0.14	0.59	0.59	0.13	0.77
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	453	198	2105	942	440	2723
v/s Ratio Prot	c0.08		c0.54		c0.12	0.60
v/s Ratio Perm		0.03		0.12		
v/c Ratio	0.56	0.24	0.90	0.20	0.93	0.78
Uniform Delay, d1	34.6	33.0	15.2	8.0	37.1	5.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.5	0.6	6.9	0.5	27.0	2.3
Delay (s)	36.1	33.6	22.2	8.5	64.1	7.9
Level of Service	D	C	C	A	E	A
Approach Delay (s)	35.2		20.2			17.1
Approach LOS	D		C			B

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	85.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1935	363	29	1925	0	18
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2103	395	32	2092	0	20
Pedestrians					2	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			2500		2866	703
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2500		2866	703
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			82		100	95
cM capacity (veh/h)			179		11	379

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1
Volume Total	701	701	701	395	32	697	697	697	20
Volume Left	0	0	0	0	32	0	0	0	0
Volume Right	0	0	0	395	0	0	0	0	20
cSH	1700	1700	1700	1700	179	1700	1700	1700	379
Volume to Capacity	0.41	0.41	0.41	0.23	0.18	0.41	0.41	0.41	0.05
Queue Length 95th (ft)	0	0	0	0	15	0	0	0	4
Control Delay (s)	0.0	0.0	0.0	0.0	29.3	0.0	0.0	0.0	15.0
Lane LOS					D				C
Approach Delay (s)	0.0				0.4				15.0
Approach LOS									C

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	47.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	1.00	0.91	1.00	0.95	0.91	0.95	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.96	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	1770	5085	1583	1681	1620	1504	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.96	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	1770	5085	1583	1681	1620	1504	1770	1863	1583
Volume (vph)	430	1246	264	255	1335	126	291	10	88	87	10	337
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	467	1354	287	277	1451	137	316	11	96	95	11	366
RTOR Reduction (vph)	0	0	111	0	0	50	0	0	81	0	0	0
Lane Group Flow (vph)	467	1354	176	277	1451	87	163	164	15	95	11	366
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Free
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	13.0	25.0	25.0	15.4	27.4	27.4	12.4	12.4	12.4	9.9	9.9	78.7
Effective Green, g (s)	13.0	25.0	25.0	15.4	27.4	27.4	12.4	12.4	12.4	9.9	9.9	78.7
Actuated g/C Ratio	0.17	0.32	0.32	0.20	0.35	0.35	0.16	0.16	0.16	0.13	0.13	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	567	1615	503	346	1770	551	265	255	237	223	234	1583
v/s Ratio Prot	0.14	0.27		c0.16	c0.29		0.10	c0.10		c0.05	0.01	
v/s Ratio Perm			0.11			0.06			0.01			c0.23
v/c Ratio	0.82	0.84	0.35	0.80	0.82	0.16	0.62	0.64	0.06	0.43	0.05	0.23
Uniform Delay, d1	31.7	25.0	20.6	30.2	23.4	17.7	30.9	31.1	28.2	31.8	30.3	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	9.4	4.0	0.4	12.5	3.1	0.1	4.2	5.5	0.1	1.3	0.1	0.3
Delay (s)	41.2	29.0	21.0	42.7	26.5	17.8	35.1	36.5	28.3	33.1	30.3	0.3
Level of Service	D	C	C	D	C	B	D	D	C	C	C	A
Approach Delay (s)		30.6			28.3			34.1			7.6	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	27.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	78.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Hina Lani Street & Ane Keohokalole Hwy

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1551	3433	3539	1551	1770	1863	1551	3433	1863	1562
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1551	3433	3539	1551	1770	1863	1551	3433	1863	1562
Volume (vph)	502	544	124	348	1020	342	296	335	186	253	251	339
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	546	591	135	378	1109	372	322	364	202	275	273	368
RTOR Reduction (vph)	0	0	105	0	0	212	0	0	155	0	0	0
Lane Group Flow (vph)	546	591	30	378	1109	160	322	364	47	275	273	368
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	14.0	20.1	20.1	21.9	28.0	28.0	16.0	20.7	20.7	10.6	15.3	89.3
Effective Green, g (s)	14.0	20.1	20.1	21.9	28.0	28.0	16.0	20.7	20.7	10.6	15.3	89.3
Actuated g/C Ratio	0.16	0.23	0.23	0.25	0.31	0.31	0.18	0.23	0.23	0.12	0.17	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	538	797	349	842	1110	486	317	432	360	408	319	1562
v/s Ratio Prot	c0.16	0.17		0.11	c0.31		c0.18	c0.20		0.08	0.15	
v/s Ratio Perm			0.02			0.10			0.03			0.24
v/c Ratio	1.01	0.74	0.09	0.45	1.00	0.33	1.02	0.84	0.13	0.67	0.86	0.24
Uniform Delay, d1	37.6	32.2	27.3	28.6	30.6	23.5	36.6	32.7	27.2	37.7	35.9	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	42.6	3.7	0.1	0.4	26.6	0.4	54.6	13.9	0.2	4.4	19.6	0.4
Delay (s)	80.2	35.9	27.5	29.0	57.2	23.9	91.3	46.6	27.3	42.1	55.5	0.4
Level of Service	F	D	C	C	E	C	F	D	C	D	E	A
Approach Delay (s)		54.0			44.8			58.4			29.3	
Approach LOS		D			D			E			C	

Intersection Summary			
HCM Average Control Delay	46.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	89.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
7: Hina Lani Street & Mamalahoa Highway

7/22/2011

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.97	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1583	3433	1863	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1583	3433	1863	3539	1583
Volume (vph)	389	400	497	568	1970	600
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	423	435	540	617	2141	652
RTOR Reduction (vph)	0	6	0	0	0	3
Lane Group Flow (vph)	423	429	540	617	2141	649
Turn Type		pm+ov	Prot			pm+ov
Protected Phases	4	5	5	2	6	4
Permitted Phases		4				6
Actuated Green, G (s)	17.0	38.0	21.0	105.0	80.0	97.0
Effective Green, g (s)	17.0	38.0	21.0	105.0	80.0	97.0
Actuated g/C Ratio	0.13	0.29	0.16	0.81	0.62	0.75
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	449	511	555	1505	2178	1230
v/s Ratio Prot	c0.12	0.14	c0.16	0.33	c0.60	0.07
v/s Ratio Perm		0.14				0.34
v/c Ratio	0.94	0.84	0.97	0.41	0.98	0.53
Uniform Delay, d1	56.0	43.1	54.2	3.6	24.3	6.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	28.3	11.5	32.1	0.8	15.7	0.4
Delay (s)	84.3	54.6	86.3	4.4	40.0	7.3
Level of Service	F	D	F	A	D	A
Approach Delay (s)	69.3			42.6	32.4	
Approach LOS	E			D	C	

Intersection Summary			
HCM Average Control Delay	41.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	89.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
8: Kealakehe Parkway & Queen Kaahumanu Highway

6/24/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	0.95	0.95	1.00	1.00	0.91	1.00	1.00	0.86	
Frpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected		0.97	1.00	0.95	0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1800	1583	1681	1691	1583	1769	5085	1549	1770	6383	
Flt Permitted		0.97	1.00	0.95	0.96	1.00	0.05	1.00	1.00	0.04	1.00	
Satd. Flow (perm)		1800	1583	1681	1691	1583	100	5085	1549	84	6383	
Volume (vph)	17	7	24	491	18	166	68	2571	723	240	2103	48
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	18	8	26	534	20	180	74	2795	786	261	2286	52
RTOR Reduction (vph)	0	0	9	0	0	135	0	0	312	0	2	0
Lane Group Flow (vph)	0	26	17	270	284	45	74	2795	474	261	2336	0
Confl. Peds. (#/hr)							2		2			2
Turn Type	Split		Perm	Split		Perm	Perm		Perm	pm+pt		
Protected Phases	4	4		8	8			2		1	6	
Permitted Phases			4			8	2		2	6		
Actuated Green, G (s)		7.1	7.1	21.0	21.0	21.0	85.2	85.2	85.2	101.2	101.2	
Effective Green, g (s)		7.1	7.1	21.0	21.0	21.0	85.2	85.2	85.2	101.2	101.2	
Actuated g/C Ratio		0.05	0.05	0.15	0.15	0.15	0.60	0.60	0.60	0.72	0.72	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		90	80	250	251	235	60	3066	934	203	4572	
v/s Ratio Prot		c0.01		0.16	c0.17			0.55		c0.11	0.37	
v/s Ratio Perm			0.01			0.03	0.74		0.31	c0.81		
v/c Ratio		0.29	0.22	1.08	1.13	0.19	1.23	0.91	0.51	1.29	0.51	
Uniform Delay, d1		64.7	64.4	60.2	60.2	52.7	28.0	24.7	16.0	50.7	9.0	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		1.8	1.4	79.8	96.9	0.4	191.8	5.3	2.0	160.5	0.4	
Delay (s)		66.4	65.8	140.0	157.0	53.1	219.9	30.1	18.0	211.2	9.4	
Level of Service		E	E	F	F	D	F	C	B	F	A	
Approach Delay (s)		66.1			125.3			31.3			29.7	
Approach LOS		E			F			C			C	

Intersection Summary				
HCM Average Control Delay	40.8	HCM Level of Service	D	
HCM Volume to Capacity ratio	1.19			
Actuated Cycle Length (s)	141.3	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	93.7%	ICU Level of Service	F	
Analysis Period (min)	15			

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
9: Hina Lani Street & Project Roadway

6/24/2011

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	215	1205	1569	29	0	147
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	234	1310	1705	32	0	160
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					TWLTL	
Median storage veh)					3	
Upstream signal (ft)			1250			
pX, platoon unblocked	0.77				0.77	0.77
vC, conflicting volume	1742				2838	863
vC1, stage 1 conf vol					1710	
vC2, stage 2 conf vol					1127	
vCu, unblocked vol	1666				3084	528
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)	2.2				3.5	3.3
p0 queue free %	20				100	58
cM capacity (veh/h)	294				52	379

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	SB 1
Volume Total	234	655	655	853	853	32	160
Volume Left	234	0	0	0	0	0	0
Volume Right	0	0	0	0	0	32	160
cSH	294	1700	1700	1700	1700	1700	379
Volume to Capacity	0.80	0.39	0.39	0.50	0.50	0.02	0.42
Queue Length 95th (ft)	158	0	0	0	0	0	51
Control Delay (s)	51.8	0.0	0.0	0.0	0.0	0.0	21.2
Lane LOS	F						C
Approach Delay (s)	7.8			0.0			21.2
Approach LOS							C

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	70.2%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frpb, ped/bikes	1.00	0.97	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1532	1766	3539	1770	1553
Flt Permitted	1.00	1.00	0.22	1.00	0.95	1.00
Satd. Flow (perm)	3539	1532	400	3539	1770	1553
Volume (vph)	1067	138	251	1405	194	103
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1160	150	273	1527	211	112
RTOR Reduction (vph)	0	40	0	0	0	93
Lane Group Flow (vph)	1160	110	273	1527	211	19
Confl. Peds. (#/hr)		5	5		5	5
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	59.4	59.4	59.4	59.4	13.5	13.5
Effective Green, g (s)	59.4	59.4	59.4	59.4	13.5	13.5
Actuated g/C Ratio	0.73	0.73	0.73	0.73	0.17	0.17
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2598	1125	294	2598	295	259
v/s Ratio Prot	0.33			0.43	c0.12	
v/s Ratio Perm		0.07	c0.68			0.01
v/c Ratio	0.45	0.10	0.93	0.59	0.72	0.07
Uniform Delay, d1	4.3	3.1	9.0	5.0	31.9	28.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.0	33.8	0.3	8.0	0.1
Delay (s)	4.4	3.1	42.8	5.4	39.9	28.5
Level of Service	A	A	D	A	D	C
Approach Delay (s)	4.2			11.0	35.9	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	80.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NBL	NBT	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1554	1770	3539	3539	1534
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1554	1770	3539	3539	1534
Volume (vph)	142	266	254	730	1444	93
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	154	289	276	793	1570	101
RTOR Reduction (vph)	0	244	0	0	0	26
Lane Group Flow (vph)	154	45	276	793	1570	75
Confl. Peds. (#/hr)	5	5	5			5
Turn Type		Perm	Prot			Perm
Protected Phases	6		7	4	8	
Permitted Phases		6				8
Actuated Green, G (s)	11.3	11.3	13.5	53.3	35.8	35.8
Effective Green, g (s)	11.3	11.3	13.5	53.3	35.8	35.8
Actuated g/C Ratio	0.16	0.16	0.19	0.73	0.49	0.49
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	275	242	329	2598	1745	756
v/s Ratio Prot	c0.09		c0.16	0.22	c0.44	
v/s Ratio Perm		0.03				0.05
v/c Ratio	0.56	0.19	0.84	0.31	0.90	0.10
Uniform Delay, d1	28.4	26.7	28.5	3.3	16.8	9.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.6	0.4	16.8	0.1	6.6	0.1
Delay (s)	30.9	27.0	45.3	3.4	23.4	9.9
Level of Service	C	C	D	A	C	A
Approach Delay (s)	28.4			14.2	22.6	
Approach LOS	C			B	C	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	72.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	872	1537	42
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	948	1671	46
Pedestrians	5			5		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	0			0		
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)					1066	
pX, platoon unblocked	0.77	0.77	0.77			
vC, conflicting volume	2171	845	1721			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2223	496	1637			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	97	96			
cM capacity (veh/h)	27	395	300			

Direction, Lane #	SB 1	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	11	11	474	474	835	835	46
Volume Left	0	11	0	0	0	0	0
Volume Right	11	0	0	0	0	0	46
cSH	395	300	1700	1700	1700	1700	1700
Volume to Capacity	0.03	0.04	0.28	0.28	0.49	0.49	0.03
Queue Length 95th (ft)	2	3	0	0	0	0	0
Control Delay (s)	14.4	17.5	0.0	0.0	0.0	0.0	0.0
Lane LOS	B	C					
Approach Delay (s)	14.4	0.2			0.0		
Approach LOS	B						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	54.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.88		1.00	0.87	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1768	3539	1542	1766	3539	1542	1764	1614		1764	1604	
Flt Permitted	0.18	1.00	1.00	0.34	1.00	1.00	0.71	1.00		0.69	1.00	
Satd. Flow (perm)	334	3539	1542	632	3539	1542	1318	1614		1289	1604	
Volume (vph)	18	706	149	42	1265	8	258	17	73	26	10	56
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	20	767	162	46	1375	9	280	18	79	28	11	61
RTOR Reduction (vph)	0	0	73	0	0	4	0	59	0	0	19	0
Lane Group Flow (vph)	20	767	89	46	1375	5	280	38	0	28	53	0
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	22.3	22.3	22.3	22.3	22.3	22.3	10.3	10.3		10.3	10.3	
Effective Green, g (s)	22.3	22.3	22.3	22.3	22.3	22.3	10.3	10.3		10.3	10.3	
Actuated g/C Ratio	0.55	0.55	0.55	0.55	0.55	0.55	0.25	0.25		0.25	0.25	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	183	1944	847	347	1944	847	334	409		327	407	
v/s Ratio Prot		0.22			c0.39			0.02			0.03	
v/s Ratio Perm	0.06		0.06	0.07		0.00	c0.21			0.02		
v/c Ratio	0.11	0.39	0.11	0.13	0.71	0.01	0.84	0.09		0.09	0.13	
Uniform Delay, d1	4.4	5.3	4.4	4.4	6.7	4.1	14.4	11.6		11.6	11.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3	0.1	0.1	0.2	1.2	0.0	16.6	0.1		0.1	0.1	
Delay (s)	4.7	5.4	4.4	4.6	7.9	4.1	30.9	11.7		11.7	11.8	
Level of Service	A	A	A	A	A	A	C	B		B	B	
Approach Delay (s)		5.2			7.8			26.0			11.8	
Approach LOS		A			A			C			B	

Intersection Summary			
HCM Average Control Delay	9.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	40.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.95	1.00	1.00	0.95
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3433	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.04	1.00
Satd. Flow (perm)	3433	1583	3539	1583	68	3539
Volume (vph)	180	84	2362	380	226	2342
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	196	91	2567	413	246	2546
RTOR Reduction (vph)	0	83	0	116	0	0
Lane Group Flow (vph)	196	8	2567	297	246	2546
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	13.3	13.3	106.0	106.0	126.0	126.0
Effective Green, g (s)	13.3	13.3	106.0	106.0	126.0	126.0
Actuated g/C Ratio	0.09	0.09	0.72	0.72	0.86	0.86
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	310	143	2547	1139	243	3027
v/s Ratio Prot	c0.06		0.73		c0.11	0.72
v/s Ratio Perm		0.01		0.19	c0.76	
v/c Ratio	0.63	0.06	1.01	0.26	1.01	0.84
Uniform Delay, d1	64.6	61.3	20.7	7.1	67.8	5.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.2	0.2	19.8	0.6	60.9	3.0
Delay (s)	68.8	61.4	40.4	7.7	128.8	8.5
Level of Service	E	E	D	A	F	A
Approach Delay (s)	66.5		35.9			19.1
Approach LOS	E		D			B

Intersection Summary			
HCM Average Control Delay	29.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	147.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	92.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	0.95	1.00	0.97	0.95
Frt	0.95	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	3332	1441	3539	1583	3433	3539
Flt Permitted	0.97	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3332	1441	3539	1583	3433	3539
Volume (vph)	271	385	2284	196	326	2341
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	295	418	2483	213	354	2545
RTOR Reduction (vph)	37	128	0	64	0	0
Lane Group Flow (vph)	388	160	2483	149	354	2545
Turn Type		Perm		Perm	Prot	
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	16.0	16.0	98.0	98.0	14.0	116.0
Effective Green, g (s)	16.0	16.0	98.0	98.0	14.0	116.0
Actuated g/C Ratio	0.11	0.11	0.70	0.70	0.10	0.83
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	381	165	2477	1108	343	2932
v/s Ratio Prot	c0.12		c0.70		c0.10	0.72
v/s Ratio Perm		0.11		0.09		
v/c Ratio	1.02	0.97	1.00	0.13	1.03	0.87
Uniform Delay, d1	62.0	61.8	21.0	7.0	63.0	7.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	50.7	61.5	18.7	0.3	57.1	3.8
Delay (s)	112.7	123.3	39.7	7.2	120.1	11.1
Level of Service	F	F	D	A	F	B
Approach Delay (s)	117.0		37.1			24.4
Approach LOS	F		D			C

Intersection Summary			
HCM Average Control Delay	40.3	HCM Level of Service	D
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	1880	489	17	2525	0	74
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2043	532	18	2745	0	80
Pedestrians					4	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					4.0	
Percent Blockage					0	
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			2579		2999	685
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			2579		2999	685
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			89		100	79
cM capacity (veh/h)			166		9	389

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1
Volume Total	681	681	681	532	18	915	915	915	80
Volume Left	0	0	0	0	18	0	0	0	0
Volume Right	0	0	0	532	0	0	0	0	80
cSH	1700	1700	1700	1700	166	1700	1700	1700	389
Volume to Capacity	0.40	0.40	0.40	0.31	0.11	0.54	0.54	0.54	0.21
Queue Length 95th (ft)	0	0	0	0	9	0	0	0	19
Control Delay (s)	0.0	0.0	0.0	0.0	29.3	0.0	0.0	0.0	16.6
Lane LOS					D				C
Approach Delay (s)	0.0				0.2				16.6
Approach LOS									C

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	52.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	1.00	0.91	1.00	0.95	0.91	0.95	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	1770	5085	1583	1681	1617	1504	1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	1770	5085	1583	1681	1617	1504	1770	1863	1583
Volume (vph)	366	1400	140	141	1509	94	550	10	378	130	10	460
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	398	1522	152	153	1640	102	598	11	411	141	11	500
RTOR Reduction (vph)	0	0	54	0	0	33	0	0	220	0	0	0
Lane Group Flow (vph)	398	1522	98	153	1640	69	304	305	191	141	11	500
Turn Type	Prot		Perm	Prot		Perm	Split		Perm	Split		Free
Protected Phases	7	4		3	8		2	2		6	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	10.1	31.4	31.4	9.4	30.7	30.7	17.0	17.0	17.0	11.8	11.8	85.6
Effective Green, g (s)	10.1	31.4	31.4	9.4	30.7	30.7	17.0	17.0	17.0	11.8	11.8	85.6
Actuated g/C Ratio	0.12	0.37	0.37	0.11	0.36	0.36	0.20	0.20	0.20	0.14	0.14	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	405	1865	581	194	1824	568	334	321	299	244	257	1583
v/s Ratio Prot	c0.12	0.30		0.09	c0.32		0.18	c0.19		c0.08	0.01	
v/s Ratio Perm			0.06			0.04			0.13			c0.32
v/c Ratio	0.98	0.82	0.17	0.79	0.90	0.12	0.91	0.95	0.64	0.58	0.04	0.32
Uniform Delay, d1	37.7	24.5	18.3	37.1	26.0	18.4	33.6	33.9	31.5	34.6	32.0	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	39.9	2.9	0.1	18.8	6.4	0.1	27.7	37.1	4.4	3.3	0.1	0.5
Delay (s)	77.6	27.4	18.4	56.0	32.3	18.5	61.3	71.0	35.9	37.9	32.1	0.5
Level of Service	E	C	B	E	C	B	E	E	D	D	C	A
Approach Delay (s)		36.4			33.5			53.9			9.1	
Approach LOS		D			C			D			A	

Intersection Summary			
HCM Average Control Delay	35.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	85.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	1.00	1.00	1.00	0.97	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1553	3433	3539	1553	1770	1863	1553	3433	1863	1562
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1553	3433	3539	1553	1770	1863	1553	3433	1863	1562
Volume (vph)	411	1146	306	325	751	259	147	273	449	342	317	461
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	447	1246	333	353	816	282	160	297	488	372	345	501
RTOR Reduction (vph)	0	0	204	0	0	200	0	0	190	0	0	0
Lane Group Flow (vph)	447	1246	129	353	816	82	160	297	298	372	345	501
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4			8			2			Free
Actuated Green, G (s)	15.7	30.0	30.0	9.0	23.3	23.3	8.5	16.0	16.0	9.0	16.5	80.0
Effective Green, g (s)	15.7	30.0	30.0	9.0	23.3	23.3	8.5	16.0	16.0	9.0	16.5	80.0
Actuated g/C Ratio	0.20	0.38	0.38	0.11	0.29	0.29	0.11	0.20	0.20	0.11	0.21	1.00
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	674	1327	582	386	1031	452	188	373	311	386	384	1562
v/s Ratio Prot	0.13	c0.35		c0.10	0.23		0.09	0.16		c0.11	0.19	
v/s Ratio Perm			0.08			0.05			c0.19			c0.32
v/c Ratio	0.66	0.94	0.22	0.91	0.79	0.18	0.85	0.80	0.96	0.96	0.90	0.32
Uniform Delay, d1	29.7	24.1	17.0	35.1	26.1	21.2	35.1	30.4	31.7	35.3	30.9	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.5	12.7	0.2	25.6	4.2	0.2	29.0	11.2	39.7	36.1	22.8	0.5
Delay (s)	32.2	36.8	17.2	60.7	30.3	21.4	64.1	41.6	71.4	71.4	53.7	0.5
Level of Service	C	D	B	E	C	C	E	D	E	E	D	A
Approach Delay (s)		32.6			36.0			60.8			37.3	
Approach LOS		C			D			E			D	

Intersection Summary			
HCM Average Control Delay	39.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	0.97	1.00	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1583	3433	1863	3539	1583
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1583	3433	1863	3539	1583
Volume (vph)	729	604	437	1095	823	519
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	792	657	475	1190	895	564
RTOR Reduction (vph)	0	17	0	0	0	32
Lane Group Flow (vph)	792	640	475	1190	895	532
Turn Type	pm+ov		Prot		pm+ov	
Protected Phases	4	5	5	2	6	4
Permitted Phases		4				6
Actuated Green, G (s)	17.0	32.5	15.5	45.0	25.5	42.5
Effective Green, g (s)	17.0	32.5	15.5	45.0	25.5	42.5
Actuated g/C Ratio	0.24	0.46	0.22	0.64	0.36	0.61
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	834	825	760	1198	1289	1052
v/s Ratio Prot	c0.23	0.18	0.14	c0.64	0.25	0.13
v/s Ratio Perm		0.24				0.23
v/c Ratio	0.95	0.78	0.62	0.99	0.69	0.51
Uniform Delay, d1	26.1	15.7	24.6	12.4	18.9	7.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	19.7	4.6	1.6	24.5	3.1	0.4
Delay (s)	45.8	20.3	26.2	36.8	22.0	8.2
Level of Service	D	C	C	D	C	A
Approach Delay (s)	34.2			33.8	16.7	
Approach LOS	C			C	B	

Intersection Summary			
HCM Average Control Delay	28.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	0.95	0.95	1.00	1.00	0.91	1.00	1.00	0.86	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected		0.96	1.00	0.95	0.95	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1795	1583	1681	1690	1583	1770	5085	1583	1770	6395	
Flt Permitted		0.96	1.00	0.95	0.95	1.00	0.05	1.00	1.00	0.05	1.00	
Satd. Flow (perm)		1795	1583	1681	1690	1583	90	5085	1583	86	6395	
Volume (vph)	59	19	71	702	20	192	60	2704	514	143	3154	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	64	21	77	763	22	209	65	2939	559	155	3428	48
RTOR Reduction (vph)	0	0	1	0	0	111	0	0	241	0	1	0
Lane Group Flow (vph)	0	85	76	382	403	98	65	2939	318	155	3475	0
Turn Type	Split		Perm	Split		Perm	Perm		Perm	pm+pt		
Protected Phases	4	4		8	8			2		1	6	
Permitted Phases			4			8	2		2	6		
Actuated Green, G (s)		12.0	12.0	29.0	29.0	29.0	83.0	83.0	83.0	93.0	93.0	
Effective Green, g (s)		12.0	12.0	29.0	29.0	29.0	83.0	83.0	83.0	93.0	93.0	
Actuated g/C Ratio		0.08	0.08	0.20	0.20	0.20	0.57	0.57	0.57	0.64	0.64	
Clearance Time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)		148	130	334	336	314	51	2891	900	124	4074	
v/s Ratio Prot		0.05		0.23	c0.24			0.58		c0.05	0.54	
v/s Ratio Perm			c0.05			0.06	0.72		0.20	c0.75		
v/c Ratio		0.57	0.59	1.14	1.20	0.31	1.27	1.02	0.35	1.25	0.85	
Uniform Delay, d1		64.5	64.6	58.5	58.5	50.0	31.5	31.5	17.0	72.2	21.1	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2		5.3	6.6	94.1	114.9	0.6	216.9	21.0	1.1	162.7	2.5	
Delay (s)		69.8	71.2	152.6	173.4	50.5	248.4	52.5	18.1	234.9	23.5	
Level of Service		E	E	F	F	D	F	D	B	F	C	
Approach Delay (s)		70.5			139.6			50.7			32.6	
Approach LOS		E			F			D			C	

Intersection Summary				
HCM Average Control Delay	53.8	HCM Level of Service	D	
HCM Volume to Capacity ratio	1.17			
Actuated Cycle Length (s)	146.0	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	96.8%	ICU Level of Service	F	
Analysis Period (min)	15			
c Critical Lane Group				

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	172	1736	1558	36	0	186
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	187	1887	1693	39	0	202
Pedestrians		5	5		5	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type					TWLTL	
Median storage veh)					3	
Upstream signal (ft)			1250			
pX, platoon unblocked	0.77				0.77	0.77
vC, conflicting volume	1738				3021	857
vC1, stage 1 conf vol					1698	
vC2, stage 2 conf vol					1322	
vCu, unblocked vol	1658				3331	510
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)					5.8	
tF (s)	2.2				3.5	3.3
p0 queue free %	36				100	48
cM capacity (veh/h)	294				67	387

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	SB 1
Volume Total	187	943	943	847	847	39	202
Volume Left	187	0	0	0	0	0	0
Volume Right	0	0	0	0	0	39	202
cSH	294	1700	1700	1700	1700	1700	387
Volume to Capacity	0.64	0.55	0.55	0.50	0.50	0.02	0.52
Queue Length 95th (ft)	101	0	0	0	0	0	73
Control Delay (s)	36.4	0.0	0.0	0.0	0.0	0.0	24.0
Lane LOS	E						C
Approach Delay (s)	3.3			0.0			24.0
Approach LOS							C

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frpb, ped/bikes	1.00	0.97	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3539	1537	1770	3539	1770	1556
Flt Permitted	1.00	1.00	0.11	1.00	0.95	1.00
Satd. Flow (perm)	3539	1537	207	3539	1770	1556
Volume (vph)	1594	142	130	1228	367	269
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1733	154	141	1335	399	292
RTOR Reduction (vph)	0	61	0	0	0	16
Lane Group Flow (vph)	1733	93	141	1335	399	276
Confl. Peds. (#/hr)		5	5		5	5
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	36.0	36.0	36.0	36.0	15.4	15.4
Effective Green, g (s)	36.0	36.0	36.0	36.0	15.4	15.4
Actuated g/C Ratio	0.61	0.61	0.61	0.61	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2145	932	125	2145	459	403
v/s Ratio Prot	0.49			0.38	c0.23	
v/s Ratio Perm		0.06	c0.68			0.18
v/c Ratio	0.81	0.10	1.13	0.62	0.87	0.69
Uniform Delay, d1	9.0	4.9	11.7	7.4	21.0	19.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.3	0.0	119.0	0.6	15.9	4.8
Delay (s)	11.4	5.0	130.7	8.0	37.0	24.6
Level of Service	B	A	F	A	D	C
Approach Delay (s)	10.8			19.7	31.7	
Approach LOS	B			B	C	

Intersection Summary			
HCM Average Control Delay	17.6	HCM Level of Service	B
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	59.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1555	1770	3539	3539	1537
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	1770	1555	1770	3539	3539	1537
Volume (vph)	163	306	293	1644	1030	107
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	177	333	318	1787	1120	116
RTOR Reduction (vph)	0	271	0	0	0	50
Lane Group Flow (vph)	177	62	318	1787	1120	66
Confl. Peds. (#/hr)	5	5	5			5
Turn Type		Perm	Prot			Perm
Protected Phases	6		7	4	8	
Permitted Phases		6				8
Actuated Green, G (s)	11.3	11.3	14.2	41.5	23.3	23.3
Effective Green, g (s)	11.3	11.3	14.2	41.5	23.3	23.3
Actuated g/C Ratio	0.19	0.19	0.23	0.68	0.38	0.38
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	329	289	413	2416	1356	589
v/s Ratio Prot	c0.10		0.18	c0.50	c0.32	
v/s Ratio Perm		0.04				0.04
v/c Ratio	0.54	0.21	0.77	0.74	0.83	0.11
Uniform Delay, d1	22.4	21.0	21.8	6.2	16.9	12.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.7	0.4	8.4	1.2	4.3	0.1
Delay (s)	24.1	21.4	30.2	7.4	21.2	12.2
Level of Service	C	C	C	A	C	B
Approach Delay (s)	22.3			10.8	20.3	
Approach LOS	C			B	C	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	60.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	0	10	10	1807	1137	49
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	11	11	1964	1236	53
Pedestrians	5			5		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	0			0		
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)					1066	
pX, platoon unblocked						
vC, conflicting volume	2245	628	1294			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2245	628	1294			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	97	98			
cM capacity (veh/h)	35	422	529			

Direction, Lane #	SB 1	NE 1	NE 2	NE 3	SW 1	SW 2	SW 3
Volume Total	11	11	982	982	618	618	53
Volume Left	0	11	0	0	0	0	0
Volume Right	11	0	0	0	0	0	53
cSH	422	529	1700	1700	1700	1700	1700
Volume to Capacity	0.03	0.02	0.58	0.58	0.36	0.36	0.03
Queue Length 95th (ft)	2	2	0	0	0	0	0
Control Delay (s)	13.8	11.9	0.0	0.0	0.0	0.0	0.0
Lane LOS	B	B					
Approach Delay (s)	13.8	0.1			0.0		
Approach LOS	B						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	61.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.88		1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1767	3539	1540	1769	3539	1540	1762	1616		1762	1653	
Flt Permitted	0.23	1.00	1.00	0.13	1.00	1.00	0.72	1.00		0.72	1.00	
Satd. Flow (perm)	432	3539	1540	244	3539	1540	1339	1616		1329	1653	
Volume (vph)	62	1501	244	69	992	29	161	11	46	16	16	34
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	67	1632	265	75	1078	32	175	12	50	17	17	37
RTOR Reduction (vph)	0	0	94	0	0	11	0	22	0	0	30	0
Lane Group Flow (vph)	67	1632	171	75	1078	21	175	40	0	17	24	0
Confl. Peds. (#/hr)	5		5	5		5	5		5	5		5
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	30.5	30.5	30.5	30.5	30.5	30.5	8.9	8.9		8.9	8.9	
Effective Green, g (s)	30.5	30.5	30.5	30.5	30.5	30.5	8.9	8.9		8.9	8.9	
Actuated g/C Ratio	0.64	0.64	0.64	0.64	0.64	0.64	0.19	0.19		0.19	0.19	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	278	2277	991	157	2277	991	251	303		250	310	
v/s Ratio Prot		c0.46			0.30			0.02			0.01	
v/s Ratio Perm	0.16		0.11	0.31		0.01	c0.13			0.01		
v/c Ratio	0.24	0.72	0.17	0.48	0.47	0.02	0.70	0.13		0.07	0.08	
Uniform Delay, d1	3.6	5.6	3.4	4.3	4.3	3.1	18.0	16.0		15.8	15.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.5	1.1	0.1	2.3	0.2	0.0	8.2	0.2		0.1	0.1	
Delay (s)	4.0	6.7	3.5	6.6	4.5	3.1	26.2	16.2		16.0	16.0	
Level of Service	A	A	A	A	A	A	C	B		B	B	
Approach Delay (s)		6.2			4.6			23.6			16.0	
Approach LOS		A			A			C			B	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	47.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Appendix N

Acoustic Study for the Proposed Kaloko Makai
Y. Ebisu & Associates
June 2011

ACOUSTIC STUDY FOR THE PROPOSED KALOKO MAKAI PROJECT

NORTH KONA, HAWAII

Prepared for:

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JUNE 2011

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CHAPTER I. SUMMARY

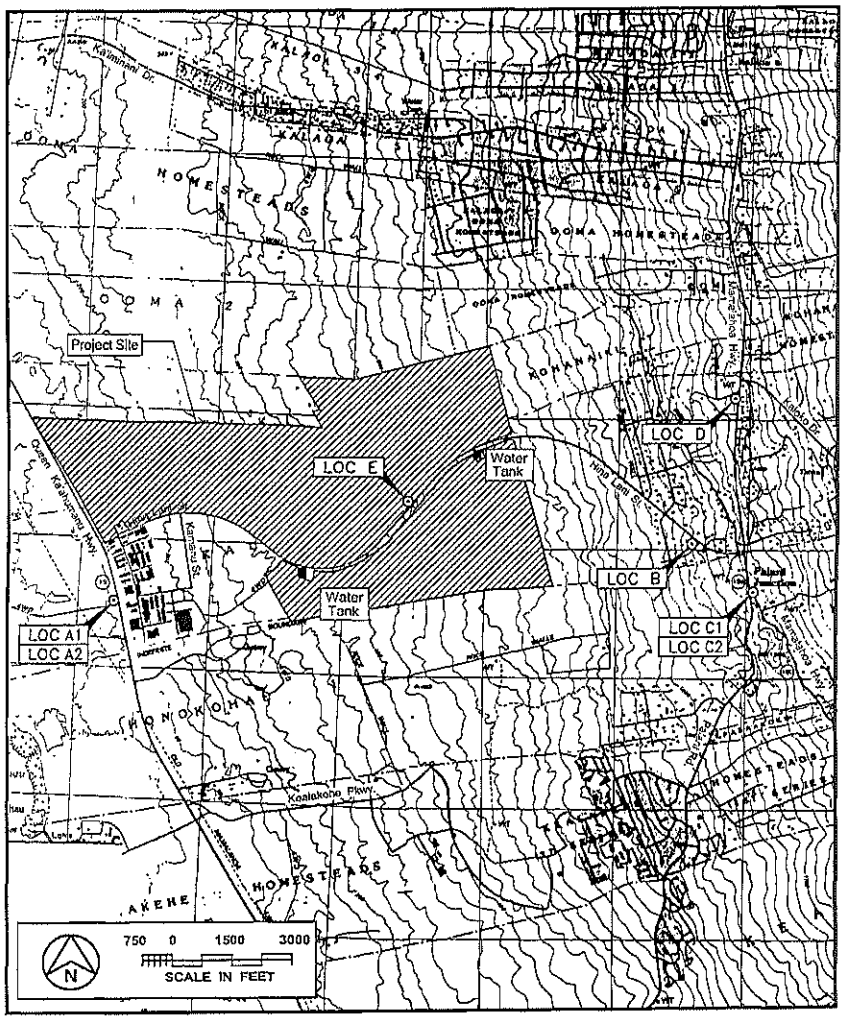
The existing and future traffic noise levels in the vicinity of the proposed Kaloko Makai Project in North Kona, Hawaii were evaluated for their potential impact on present and future noise sensitive areas. Figure 1 depicts the location of the project site. The future traffic noise levels along the primary access roadways to the project were calculated for the year 2035.

Along the existing Queen Kaahumanu Highway, traffic noise levels are expected to increase by 13.8 to 14.1 DNL between CY 2011 and CY 2035 as a result of both project and non-project traffic. Along Hina Lani Street, traffic noise levels are predicted to increase by 6.5 to 10.4 DNL. Traffic noise increases due to project traffic are predicted to range from 4.0 to 11.3 DNL, which are typically greater than the range of the noise increases caused by non-project traffic on these two roadways. These increases in traffic noise levels associated with project traffic range from the moderate to the moderately significant. The larger and more significant increases in traffic noise levels are expected to occur along Queen Kaahumanu Highway, where the lands along the highway Rights-of-Way are generally undeveloped or are developed with commercial uses. Adequate setback distances have been provided between the project's noise sensitive uses and Queen Kaahumanu Highway.

Along Mamalahoa Highway, noise impacts from project traffic should be difficult to measure or quantify, and should be much less than those associated with non-project traffic. Traffic noise mitigation measures in the form of increased setbacks, sound attenuation walls, and/or closure and air conditioning will probably be required at proposed residences which front Hina Lani Street and Ane Keahokalole Highway, and possibly for the planned school fronting Ane Keahokalole Highway.

Based on previously published 14 CFR Part 150 aircraft noise contours for Kona International Airport at Keahole (KOA), the project site is located outside of the existing and forecasted 60 and 55 DNL noise contours, and is considered to be acceptable for the development of noise sensitive uses as planned. Noise contours for CY 2008, CY 2013, and CY 2030, which were developed during the 2009 Master Plan and 14 CFR Part 150 Study updates for KOA, confirm that the project site is outside of the airport noise contours, and special aircraft noise attenuation measures are not required over the project area. The implementation of the airport noise disclosure provisions of Act 208 is not considered to be necessary over the entire project area because the existing and forecasted 55 DNL noise contours are not expected to encompass noise sensitive developments within the project area.

Unavoidable, but temporary, noise impacts may occur during the construction of the proposed project. Because construction activities are predicted to be audible at adjoining properties, the quality of the acoustic environment may be degraded to unacceptable levels during periods of construction. Mitigation measures to reduce



PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS

FIGURE 1

construction noise to inaudible levels will not be practical in all cases. For this reason, the use of quiet equipment and construction curfew periods as required under the State Department of Health noise regulations are recommended to minimize construction noise impacts.

CHAPTER II. PURPOSE

The objectives of this study were to describe the existing and future noise environment in the environs of the proposed Kaloko Makai Project in North Kona on the island of Hawaii. Traffic noise level increases and impacts associated with the proposed development were to be determined within the project site as well as along the public roadways expected to service the project traffic. A specific objective was to determine the future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases. Assessments of possible impacts from noise resulting from fixed and rotary wing aircraft operations at nearby Kona International Airport at Keahole, and from short term construction noise at the project site were also included in the noise study objectives. Recommendations for minimizing these noise impacts were also to be provided as required.

CHAPTER III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

The noise descriptor currently used by federal agencies to assess environmental noise is the Day-Night Average Sound Level (DNL or Ldn). This descriptor incorporates a 24-hour average of instantaneous A-Weighted sound levels as read on a standard Sound Level Meter. The maximum A-Weighted sound level occurring while a noise source such as a heavy truck or aircraft is moving past a listener (i.e., the maximum sound level from a "single event") is referred to as the "Lmax value". The mathematical product (or integral) of the instantaneous sound level times the duration of the event is known as the "Sound Exposure Level", or Lse, which is analogous to the energy of the time-varying sound levels associated with a single event.

The DNL values represent the average noise during a typical day of the year. DNL exposure levels of 55 or less are typical of quiet rural or suburban areas. DNL exposure levels of 55 to 65 are typical of urbanized areas with medium to high levels of activity and street traffic. DNL exposure levels above 65 are representative of densely developed urban areas and areas fronting high volume roadways.

By definition, the minimum averaging period for the DNL descriptor is 24 hours. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the DNL descriptor. Because of the averaging used, DNL values in urbanized areas typically range between 50 and 75 DNL. In comparison, the typical range of intermittent noise events may have maximum Sound Level Meter readings between 75 and 105 dBA. A more complete list of noise descriptors is provided in Appendix B to this report. In Appendix B, the Ldn descriptor symbol is used in place of the DNL descriptor symbol.

Table 1, extracted from Reference 1, categorizes the various DNL levels of outdoor noise exposure with severity classifications. Table 2, also extracted from Reference 1, presents the general effects of noise on people in residential use situations. Figure 2, extracted from Reference 2, presents suggested land use compatibility guidelines for residential and nonresidential land uses. A general consensus among federal agencies has developed whereby residential housing development is considered acceptable in areas where exterior noise does not exceed 65 DNL. This value of 65 DNL is used as a federal regulatory threshold for determining the necessity for special noise abatement measures when applications for federal funding assistance are made.

As a general rule, noise levels of 55 DNL or less occur in rural areas, or in areas which are removed from high volume roadways. In urbanized areas which are shielded from high volume streets, DNL levels generally range from 55 to 65 DNL, and are usually controlled by motor vehicle traffic noise. Residences which front major roadways are generally exposed to levels of 65 DNL, and as high as 75 DNL when the

TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY–NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL (1) STANDARD
Minimal Exposure	Not Exceeding 55 DNL	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 DNL But Not Above 65 DNL	Above 55 Leq But Not Above 65 Leq	Acceptable(2)
Significant Exposure	Above 65 DNL But Not Above 75 DNL	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 DNL	Above 75 Leq	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.

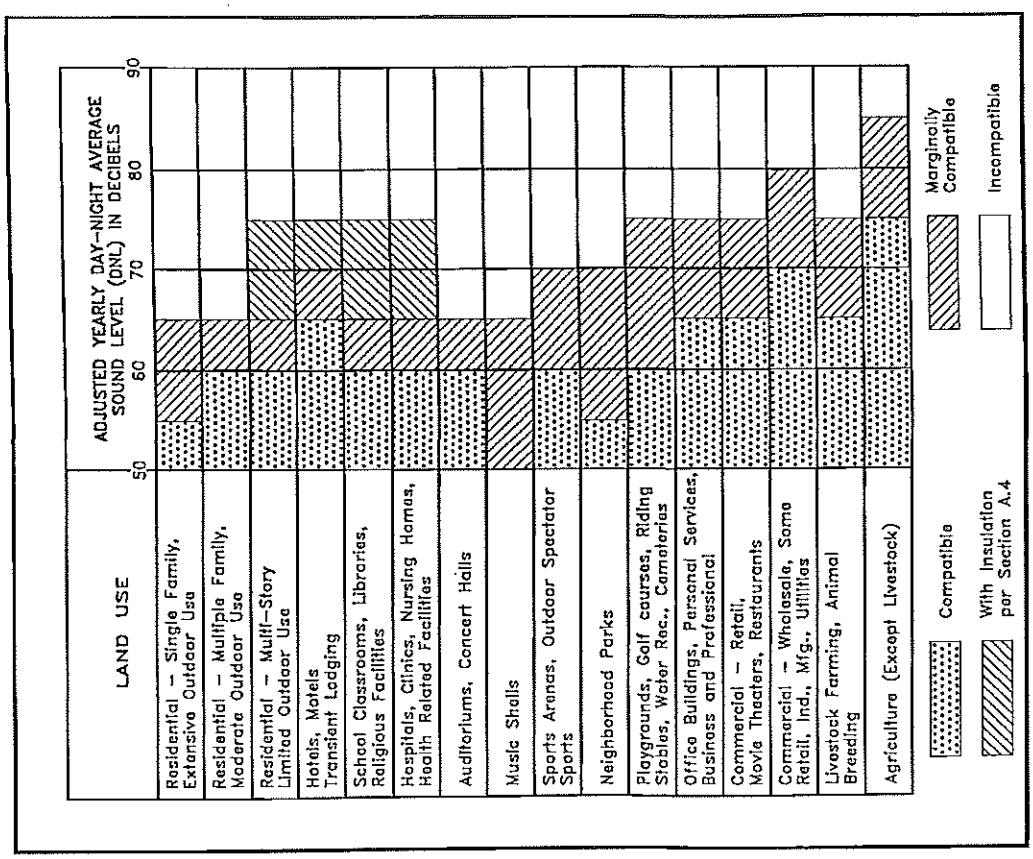


FIGURE 2

LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY–NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9–1998/Part 5)

TABLE 2

EFFECTS OF NOISE ON PEOPLE (Residential Land Uses Only)

EFFECTS[1] / DAY-NIGHT AVERAGE SOUND LEVEL IN DECIBELS	Hearing Loss	Speech Interference		Annoyance[2]	Average Community Reaction[4]	General Community Attitude Towards Area
		Indoor	Outdoor			
	Qualitative Description	%Sentence Intelligibility	Distance in Meters for 95% Sentence Intelligibility	% of Population Highly Annoyed[3]		
75 and above	May Begin to Occur	98%	0.5	37%	Very Severe	Noise is likely to be the most important of all adverse aspects of the community environment.
70	Will Not Likely Occur	99%	0.9	25%	Severe	Noise is one of the most important adverse aspects of the community environment.
65	Will Not Occur	100%	1.5	15%	Significant	Noise is one of the important adverse aspects of the community environment.
60	Will Not Occur	100%	2.0	9%	Moderate to Slight	Noise may be considered an adverse aspect of the community environment.
55 and below	Will Not Occur	100%	3.5	4%		Noise considered no more important than various other environmental factors.

1. "Speech Interference" data are drawn from the following tables in EPA's "Levels Document": Table 3, Fig. D-1, Fig. D-2, Fig. D-3. All other data from National Academy of Science 1977 report "Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise."

2. Depends on attitudes and other factors.

3. The percentages of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time.

4. Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE: Research implicates noise as a factor producing stress-related health effects such as heart disease, high-blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been quantified.

roadway is a high speed freeway. Due to noise shielding effects from intervening structures, interior lots are usually exposed to 3 to 10 DNL lower noise levels than the front lots which are not shielded from the traffic noise.

For the purposes of determining noise acceptability for funding assistance from federal agencies, an exterior noise level of 65 DNL or lower is considered acceptable. These federal agencies include the Federal Aviation Administration (FAA), Department of Defense (DOD); Federal Housing Administration, Housing and Urban Development (FHA/HUD), and Veterans Administration (VA). This standard is applied nationally (see Reference 3), including Hawaii.

Because of our open-living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated structures, an exterior noise level of 65 DNL does not eliminate all risks of noise impacts. Because of these factors, a lower level of 55 DNL is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior noise (see Reference 4). For typical, naturally ventilated structures in Hawaii, an exterior noise level of 55 DNL results in an interior level of approximately 45 DNL, which is considered to be the "Unconditionally Acceptable" (or "Near-Zero Risk") level of interior noise. However, after considering the cost and feasibility of applying the lower level of 55 DNL, government agencies such as FHA/HUD and VA have selected 65 DNL as a more appropriate regulatory standard.

For aircraft noise, the Hawaii State Department of Transportation, Airports Division (HDOTA), has recommended that 60 DNL be used as the common level for determining land use compatibility in respect to noise sensitive uses near its airports. Table 3 summarizes the recommendations for compatible land uses at various levels of aircraft noise. For those noise sensitive land uses which are exposed to aircraft noise greater than 55 DNL, the division recommends that disclosure of the aircraft noise levels be provided prior to any real property transactions. Reference 5 requires that such disclosure be provided prior to real property transactions concerning properties located within Air Installation Compatibility Use Zones (AICUZ) or located within airport noise maps developed under Federal Aviation Regulation (FAR) Part 150 - Airport Noise Compatibility Planning (14 CFR Part 150). The most recent FAR Part 150 noise contours for Kona International Airport at Keahole were completed in 2009 and reflect conditions through 2013 (Reference 6). Additional airport noise contours for 2030 were developed by the HDOTA for information purposes only. These airport noise contours do not indicate that significant increases in aircraft noise will occur over the project site.

For commercial, industrial, and other non-noise sensitive land uses, exterior noise levels as high as 75 DNL are generally considered acceptable. Exceptions to this occur when naturally ventilated office and other commercial establishments are exposed to exterior levels which exceed 65 DNL.

TABLE 3

HAWAII STATE DEPARTMENT OF TRANSPORTATION RECOMMENDATIONS FOR LOCAL LAND USE COMPATIBILITY WITH YEARLY DAY–NIGHT AVERAGE SOUND LEVELS (DNL)

TYPE OF LAND USE	**** Yearly Day-Night Average Sound Level ****					
	< 60	60-65	65-70	70-75	75-80	80-85
RESIDENTIAL						
Low density residential, resorts, and hotels (outdoor facil.)	Y(a)	N(b)	N	N	N	N
Low density apartment with moderate outdoor use	Y	N(b)	N	N	N	N
High density apartment with limited outdoor use	Y	N(b)	N(b)	N	N	N
Transient lodgings with limited outdoor use	Y	N(b)	N(b)	N	N	N
PUBLIC USE						
Schools, day-care centers, libraries, and churches	Y	N(c)	N(c)	N(c)	N	N
Hospitals, nursing homes, clinics, and health facilities	Y	Y(d)	Y(d)	Y(d)	N	N
Indoor auditoriums and concert halls	Y(c)	Y(c)	N	N	N	N
Government services and office buildings serving the general public	Y	Y	Y(d)	Y(d)	N	N
Transportation and Parking	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
COMMERCIAL AND GOVERNMENT USE						
Offices - government, business, and professional	Y	Y	Y(d)	Y(d)	N	N
Wholesale and retail - building materials, hardware and heavy equipment	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
Airport businesses - car rental, tours, lei stands, ticket offices, etc.	Y	Y	Y(d)	Y(d)	N	N
Retail, restaurants, shopping centers, financial institutions, etc.	Y	Y	Y(d)	Y(d)	N	N
Power plants, sewage treatment plants, and base yards	Y	Y	Y(d)	Y(d)	Y(d)	N
Studios without outdoor sets, broadcasting, production facilities, etc.	Y(c)	Y(c)	N	N	N	N
MANUFACTURING, PRODUCTION, AND STORAGE						
Manufacturing, general	Y	Y	Y(d)	Y(d)	Y(d)	N
Photographic and optical	Y	Y	Y(d)	Y(d)	N	N
Agriculture (except livestock) and forestry	Y	Y(e)	Y(e)	Y(e)	Y(e)	Y(e)
Livestock farming and breeding	Y	Y(e)	Y(e)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y(f)	Y(f)	N	N	N
Outdoor music shells, amphitheaters	Y(f)	N	N	N	N	N
Nature exhibits and zoos, neighborhood parks	Y	Y	Y	N	N	N
Amusements, beach parks, active playgrounds, etc.	Y	Y	Y	Y	N	N
Public golf courses, riding stables, cemeteries, gardens, etc.	Y	Y	N	N	N	N
Professional/resort sport facilities, locations of media events, etc.	Y(f)	N	N	N	N	N
Extensive natural wildlife and recreation areas	Y(f)	N	N	N	N	N

Numbers in parentheses refer to notes.

KEY TO TABLE 3:

Y(Yes) = Land Use and related structures compatible without restrictions.
N(No) = Land Use and related structures are not compatible and should be prohibited.

TABLE 3 (CONTINUED)

HAWAII STATE DEPARTMENT OF TRANSPORTATION RECOMMENDATIONS FOR LOCAL LAND USE COMPATIBILITY WITH YEARLY DAY–NIGHT AVERAGE SOUND LEVELS (DNL)

NOTES FOR TABLE 3:

(a) A noise level of 60 DNL does not eliminate all risks of adverse noise impacts from aircraft noise. However, the 60 DNL planning level has been selected by the State Airports Division as an appropriate compromise between the minimal risk level of 55 DNL and the significant risk level of 65 DNL.

(b) Where the community determines that these uses must be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 DNL or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure plus air conditioning may be required to provide additional outdoor to indoor NLR, and will not eliminate outdoor noise problems.

(c) Because the DNL noise descriptor system represents a 24-hour average of individual aircraft noise events, each of which can be unique in respect to amplitude, duration, and tonal content, the NLR requirements should be evaluated for the specific land use, interior acoustical requirements, and properties of the aircraft noise events. NLR requirements should not be based solely upon the exterior DNL exposure level.

(d) Measures to achieve required NLR must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(e) Residential buildings require NLR. Residential buildings should not be located where noise is greater than 65 DNL.

(f) Impact of amplitude, duration, frequency, and tonal content of aircraft noise events should be evaluated.

In the State of Hawaii, the State Department of Health (DOH) regulates noise from on-site activities. State DOH noise regulations are expressed in maximum allowable property line noise limits rather than DNL (see Reference 7). The noise limits apply on all islands of the State, including Hawaii. Although they are not directly comparable to noise criteria expressed in DNL, State DOH noise limits for preservation/residential, apartment/commercial, and agricultural/industrial lands equate to approximately 55, 60, and 76 DNL, respectively.

Because the proposed project site is located on lands designated for single family and multifamily residential, and commercial uses, various DOH noise limits would be applicable along the lot boundary lines or receptor locations for any stationary machinery, or equipment related to commercial or construction activities. These property line limits are 60 dBA and 50 dBA during the daytime and nighttime periods, respectively, for commercial lots or receptors. For multifamily or apartment use, the State DOH limits are also 60 dBA and 50 dBA during the daytime and nighttime periods, respectively. For single family residential and public facility uses, the State DOH limits are 55 dBA and 45 dBA during the daytime and nighttime periods, respectively. These noise limits cannot be exceeded for more than 2 minutes in any 20-minute time period under the State DOH noise regulations. The State DOH noise regulations do not apply to aircraft or motor vehicles.

TABLE 4
TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

	LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
A1	50 FT from centerline of Q. Kaahumanu Hwy. (4/27/09)	0700 TO 0800	58	1,565	46	49	73.3	73.3
A2	100 FT from centerline of Q. Kaahumanu Hwy. (4/27/09)	0700 TO 0800	58	1,565	46	49	67.9	67.8
B	50 FT from centerline of Hina Lani Street (4/27/09)	0820 TO 0920	58	336	5	8	66.3	66.2
C1	50 FT from centerline of Mamalahoa Hwy. (4/27/09)	0935 TO 1035	50	682	3	6	66.0	66.6
C2	100 FT from centerline of Mamalahoa Hwy. (4/27/09)	0935 TO 1035	50	682	3	6	61.8	61.1
D	50 FT from centerline of Mamalahoa Hwy. (4/27/09)	1049 TO 1149	51	758	12	4	67.5	67.5

CHAPTER IV. GENERAL STUDY METHODOLOGY

Existing traffic and background ambient noise levels were measured at seven locations in the project environs to provide a basis for developing the traffic noise contours along the roadways which will service the proposed development: Queen Kaahumanu Highway, Hina Lani Street, and Mamalahoa Highway; and for determining the existing background ambient noise levels in the project area.

The locations of the measurement sites are shown in Figure 1. Noise measurements were performed during April 2009. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in Table 4. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the computer model used.

Traffic noise calculations for the existing conditions as well as noise predictions for the future conditions with and without the project were performed using the Federal Highway Administration (FHWA) Noise Prediction Model (Reference 8). Traffic data entered into the noise prediction model were: hourly traffic volumes, average vehicle speeds, estimates of traffic mix, and loose soil propagation loss factor. The traffic assignments for the project (Reference 9) and Hawaii State Department of Transportation counts on Queen Kaahumanu Highway (Reference 10) were the primary sources of data inputs to the model. For existing and future traffic, it was assumed that the average noise levels, or Leq(h), during the AM peak hour were equal to the 24-hour DNL along Queen Kaahumanu and Mamalahoa Highways. This assumption was based on computations of both the hourly Leq and the 24-hour DNL of traffic noise on Queen Kaahumanu Highway (see Figure 3). For the other roadways, it was assumed that the 24-hour DNL was equal to the average noise level during the PM peak hour.

Traffic noise calculations for both the existing and future conditions in the project environs were developed for ground level receptors without the benefit of shielding effects. Traffic assignments with and without the project were obtained from the project's traffic turning movements (Reference 9). The forecasted increases in traffic noise levels over existing levels were calculated for both scenarios, and noise impact risks evaluated. The relative contributions of non-project and project related traffic to the total noise levels were also calculated, and an evaluation was made of possible traffic noise impacts resulting from the project.

The relationships of the aircraft flight tracks and noise contours for Kona International Airport at Keahole to the project site and its proposed land uses were examined to determine if potential noise impacts were possible at the project site. The locations of the airport noise contours for 2008, 2013, and 2030 were compared with the location of the project site, and risks of noise impacts were evaluated. The need for special aircraft noise attenuation measures or disclosures of aircraft noise level at the project site was determined by comparing the locations of the most recently published

FIGURE 3

HOURLY VARIATIONS OF TRAFFIC NOISE AT 100 FT SETBACK DISTANCE FROM THE CENTERLINE OF QUEEN KAAHUMANU HWY. BETWEEN OTEC ACCESS RD. AND HULIKOA ST. AT 95 MILEPOST

(Sta. B71001909280, 5/31/06)

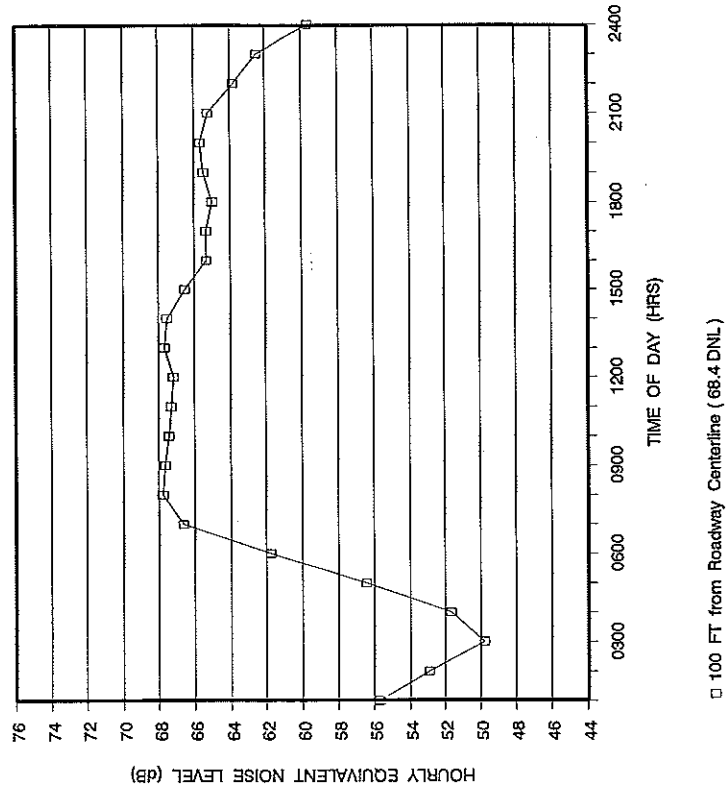


TABLE 4 (CONTINUED)
TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

	LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
E	50 FT from centerline of Hina Lani Street (4/27/09)	1436 TO 1536	55	547	9	12	67.5	67.6
A1	50 FT from centerline of Q. Kaahumanu Hwy. (4/27/09)	1555 TO 1655	49	1,931	27	5	71.4	70.8
A2	100 FT from centerline of Q. Kaahumanu Hwy. (4/27/09)	1555 TO 1655	49	1,931	27	5	63.2	65.3

Year 2013 14 CFR Part 150 airport noise contours with the location of the project site.

Traffic Noise. The existing traffic noise levels in the project environs vary from levels of approximately 62 DNL along the makai (west) property boundary, to less than 55 DNL at the mauka (east) property boundary and interior locations of the project site. Traffic noise levels along Queen Kaahumanu Highway are less than 65 DNL at 141 FT or greater setback distances from the highway centerline. Traffic noise levels along Mamalahoa Highway are less than 65 DNL at 95 FT or greater setback distances from the highway centerline. Along the east boundary of the project site which is removed from Hina Lani Street, existing background ambient noise levels are very low and less than 55 DNL.

Calculations of existing traffic noise levels during the AM and PM peak traffic hours are presented in Tables 5A and 5B. The hourly Leq (or Equivalent Sound Level) contribution from each roadway section in the project environs was calculated for comparison with forecasted traffic noise levels with and without the project. The existing setback distances from the roadways' centerlines to their associated 65 and 75 DNL contours were also calculated as shown in Table 6. The contour line setback distances do not take into account noise shielding effects or the additive contributions of traffic noise from intersecting street sections. Based on the results of Table 6, it was concluded that the existing 65 DNL traffic noise contour is located approximately 132 to 141 FT from the centerline of Queen Kaahumanu Highway, and approximately 93 to 95 FT from the centerline of Mamalahoa Highway in the immediate vicinity of the project site.

Existing traffic noise levels at the interior portions of the project site are controlled by the traffic along Hina Lani Street, and are approximately 65 to 69 DNL at 50 FT from the centerline of Hina Lani Street. At the interior locations on the project site which are removed from Hina Lani Street and Queen Kaahumanu Highway, existing background noise levels drop to 55 DNL or less, and aircraft noise and the natural sounds of birds and winds in foliage are the dominant noise sources. A discussion of existing aircraft noise levels on the project site is provided in the following section. Between intermittent noise events, background ambient noise levels drop to a range of 35 to 40 dB. During calm wind periods, background ambient noise levels decrease to levels less than 40 dB. The minimum background ambient noise levels at these interior locations are controlled by distant traffic and wind noise.

Aircraft Noise. Aircraft noise sources in the project environs are associated with fixed and rotary wing aircraft operations at Kona International Airport at Keahole. Figures 4 through 6 depict aircraft flight tracks in the project environs, which were similar to those reported in Reference 6. Occasionally, depending on weather, visibility, or air traffic conditions, helicopter and light, fixed wing aircraft may cross over the western boundary of project site as indicated by the average departure and arrival tracks shown in Figures 4 and 5, respectively. The noisier jet aircraft flight tracks

TABLE 5A

EXISTING (CY 2011) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM PEAK HOUR)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	50' Leq	100' Leq	200' Leq
Mamalahoa Hwy. - N. of Hina Lani St.	51	1,418	1,390	14	14	70.2	64.6	58.5
Mamalahoa Hwy. - S. of Hina Lani St.	50	1,428	1,400	14	14	69.9	64.4	58.3
Hina Lani St. - W. of Mamalahoa Hwy.	58	386	372	5	9	66.7	61.1	55.1
Hina Lani St. - E. of Ane Keahokalole Hwy.	55	321	309	5	7	65.1	59.6	53.6
Ane Keahokalole Hwy. - N. of Hina Lani St.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ane Keahokalole Hwy. - S. of Hina Lani St.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hina Lani St. - W. of Ane Keahokalole Hwy.	55	321	309	5	7	65.1	59.6	53.6
Hina Lani St. - E. of Kamanu St.	55	321	309	5	7	65.1	59.6	53.6
Hina Lani St. - W. of Kamanu St.	45	369	355	6	8	63.2	57.8	52.1
Hina Lani St. - E. of Q. Kaahumanu Hwy.	45	947	912	15	20	67.3	61.9	56.1
Kamanu St. - N. of Hina Lani St.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Q. Kaahumanu Hwy. - N. of Hina Lani St.	58	1,509	1,422	42	45	72.9	67.4	61.4
Q. Kaahumanu Hwy. - S. of Hina Lani St.	58	1,742	1,641	49	52	73.5	68.0	62.0

TABLE 5B

EXISTING (CY 2011) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (PM PEAK HOUR)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	50' Leq	100' Leq	200' Leq
Mamalahoa Hwy. - N. of Hina Lani St.	51	1,178	1,154	12	12	69.4	63.8	57.7
Mamalahoa Hwy. - S. of Hina Lani St.	50	1,189	1,165	12	12	69.1	63.6	57.5
Hina Lani St. - W. of Mamalahoa Hwy.	58	563	542	8	13	68.3	62.8	56.7
Hina Lani St. - E. of Ane Keahokalole Hwy.	55	499	481	8	10	67.0	61.5	55.5
Ane Keahokalole Hwy. - N. of Hina Lani St.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ane Keahokalole Hwy. - S. of Hina Lani St.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hina Lani St. - W. of Ane Keahokalole Hwy.	55	499	481	8	10	67.0	61.5	55.5
Hina Lani St. - E. of Kamanu St.	55	499	481	8	10	67.0	61.5	55.5
Hina Lani St. - W. of Kamanu St.	45	649	625	10	14	65.6	60.3	54.5
Hina Lani St. - E. of Q. Kaahumanu Hwy.	45	1,485	1,430	24	31	69.2	63.8	58.1
Kamanu St. - N. of Hina Lani St.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Q. Kaahumanu Hwy. - N. of Hina Lani St.	49	1,777	1,747	25	5	70.4	64.9	50.7
Q. Kaahumanu Hwy. - S. of Hina Lani St.	49	2,284	2,245	32	7	71.5	66.0	59.8

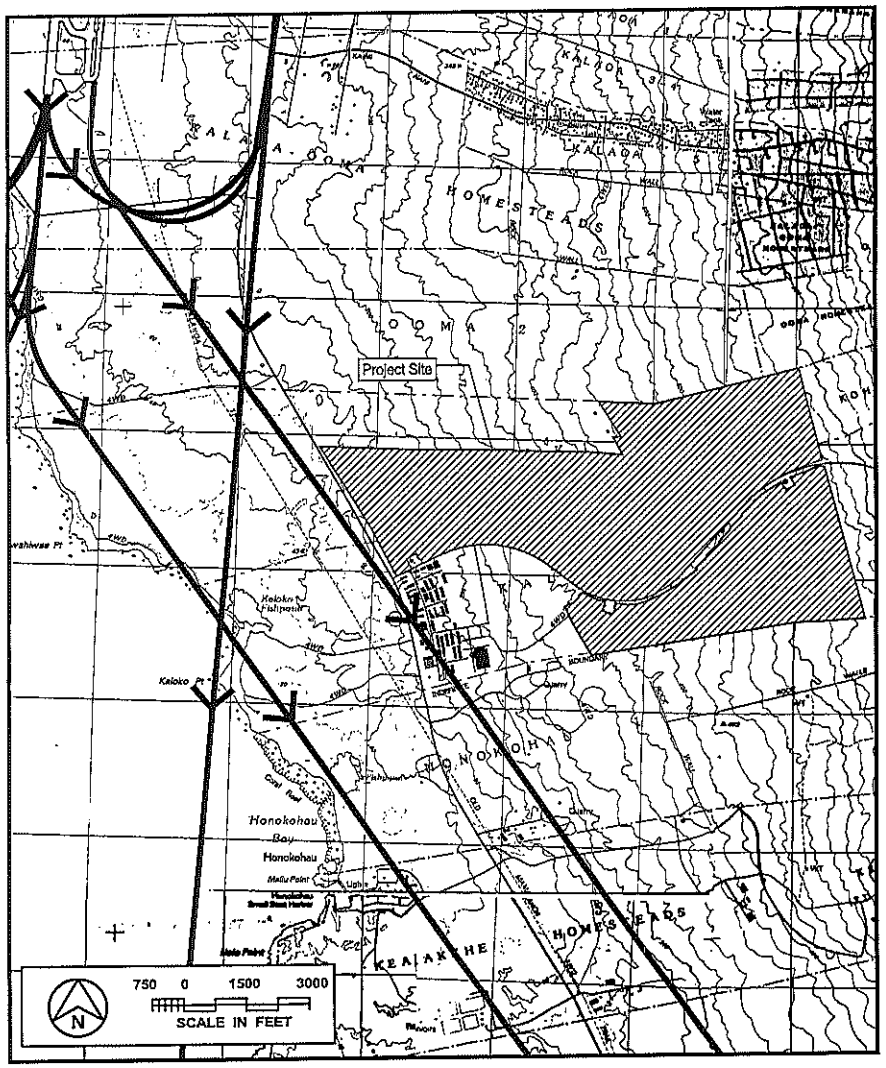
TABLE 6

YEAR 2011 AND 2035 DISTANCES TO 65 AND 75 DNL CONTOURS

STREET SECTION	65 DNL SETBACK (FT) CY 2011	65 DNL SETBACK (FT) CY 2035	75 DNL SETBACK (FT) CY 2011	75 DNL SETBACK (FT) CY 2035
Mamalahoa Hwy. - N. of Hina Lani St.	95	151	28	45
Mamalahoa Hwy. - S. of Hina Lani St.	93	145	26	43
Hina Lani St. - W. of Mamalahoa Hwy.	76	158	21	54
Hina Lani St. - E. of Ane Keahokalole Hwy.	64	174	18	59
Ane Keahokalole Hwy. - N. of Hina Lani St.	N/A	107	N/A	37
Ane Keahokalole Hwy. - S. of Hina Lani St.	N/A	102	N/A	35
Hina Lani St. - W. of Ane Keahokalole Hwy.	64	200	18	69
Hina Lani St. - E. of Kamanu St.	64	206	18	71
Hina Lani St. - W. of Kamanu St.	54	177	15	59
Hina Lani St. - E. of Q. Kaahumanu Hwy.	86	192	24	64
Kamanu St. - N. of Hina Lani St.	N/A	49	N/A	13
Q. Kaahumanu Hwy. - N. of Hina Lani St.	132	338	38	202
Q. Kaahumanu Hwy. - S. of Hina Lani St.	141	354	41	212

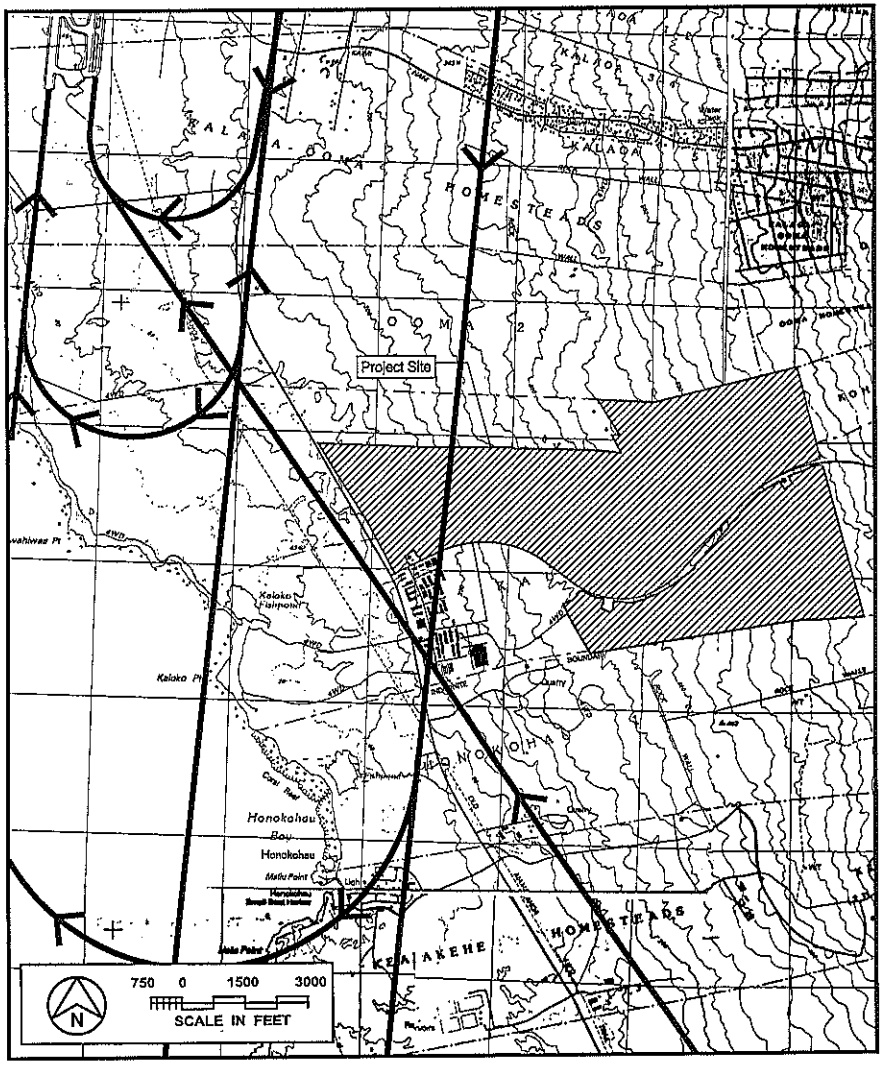
Notes:

(1) All setback distances are from the roadways' centerlines.
(2) See Tables 5A, 5B, 7A, and 7B for traffic volume, speed, and mix assumptions.
(3) Setback distances are for unobstructed line-of-sight conditions.



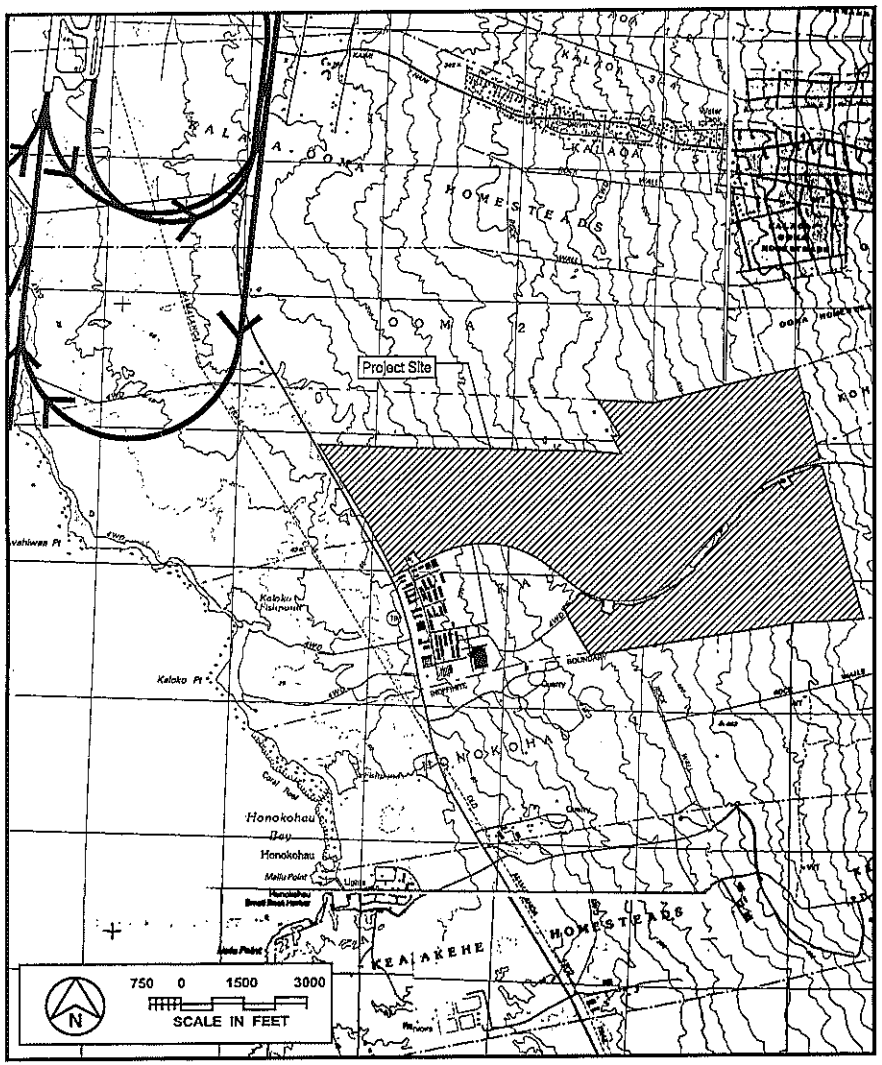
LOCATIONS OF EXISTING AVERAGE AIRCRAFT DEPARTURE FLIGHT TRACKS IN PROJECT ENVIRONS

FIGURE 4



LOCATIONS OF EXISTING AVERAGE AIRCRAFT ARRIVAL FLIGHT TRACKS IN PROJECT ENVIRONS

FIGURE 5



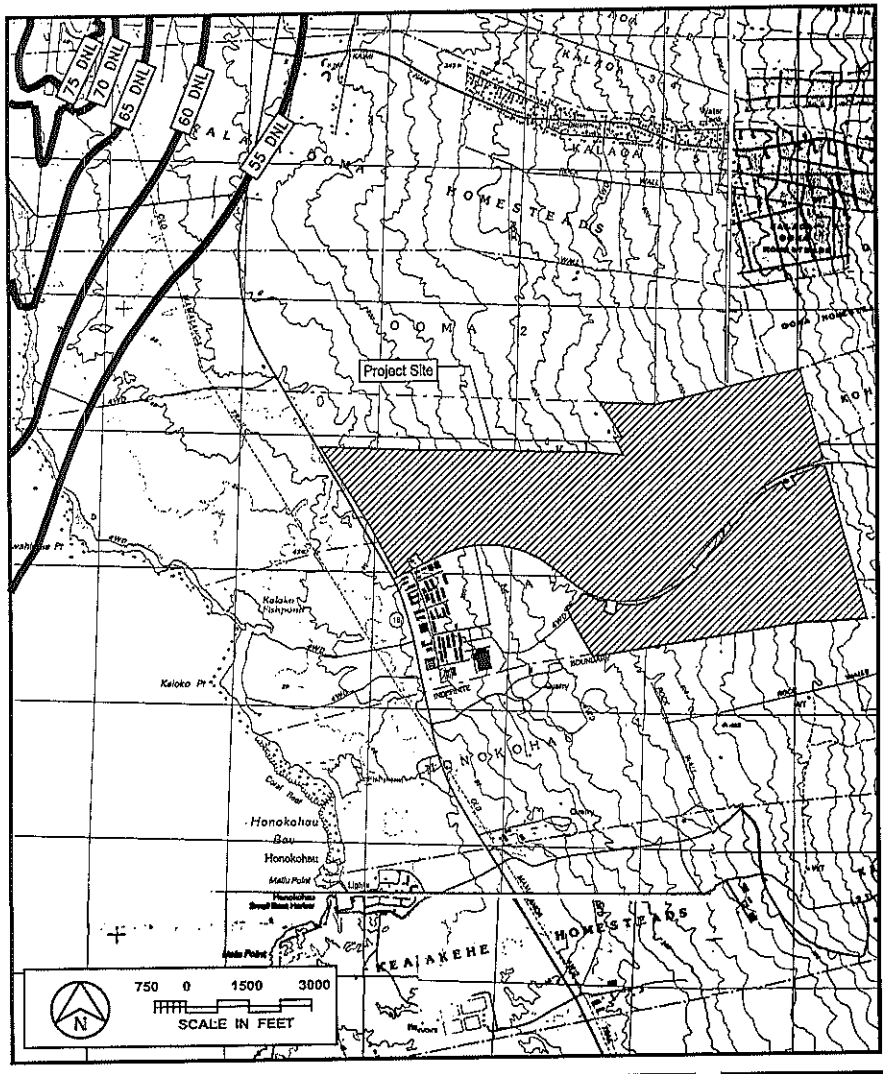
LOCATIONS OF EXISTING AVERAGE AIRCRAFT TRAINING FLIGHT TRACKS IN PROJECT ENVIRONS

FIGURE 6

typically remain offshore and west of the project site, and are aligned with Kona International Airport's single runway. However, large overseas jet aircraft may occasionally overfly the west end of the project site where shown in Figure 5 when landing while using a right hand turn during north flow pattern conditions (Runway 35 in use). This approach to the airport is used due to the presence of other aircraft traffic approaching the airport from the west.

Figure 7 depicts the locations of the 55 through 75 DNL aircraft noise contours during the CY 2008 period. These noise contours were obtained from the Kona International Airport At Keahole 14 CFR Part 150 report (Reference 6). From Figure 7, aircraft noise levels over the project site are below 55 DNL, and as such, are considered to be in the "Minimal Exposure, Unconditionally Acceptable" category for the planned land uses on the project site.

Based on the most current information on aircraft noise levels at Kona International Airport At Keahole, the location of the existing 55 DNL contour is estimated to be approximately 1 mile northwest of the project site as shown in Figure 7. The location of the existing 60 DNL contour is estimated to be approximately 1.3 miles northwest of the project site. Based on these 14 CFR Part 150 noise contours for Kona International Airport At Keahole, and their relationships to the project site, it was concluded that the 60 DNL aircraft noise contour is located outside the project site, with at least 10 DNL of margin for increased contour expansion. The 55 DNL aircraft noise contour also does not cross through the project site, and has a smaller 5 DNL of margin for increased contour expansion. Based on these airport noise contours in the project environs, it was concluded that special aircraft noise mitigation measures are not required, and existing aircraft noise levels do not place special development constraints on the project site.



2008 14 CFR PART 150 NOISE CONTOURS FOR KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 7

CHAPTER VI. FUTURE NOISE ENVIRONMENT

Traffic Noise. Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 9 for CY 2035 with the proposed project and associated with project-only traffic contributions. The CY 2035 traffic turning movements without the project were derived by subtracting the "project-only" from the total "project plus non-project" values. The future assignments of project plus non-project traffic on the roadway sections which would service the project are shown in Tables 7A and 7B for the AM and PM peak hours of traffic, respectively. As indicated in Table 8, by CY 2035 and following complete project build-out, traffic noise levels on Queen Kaahumanu Highway in the areas fronting the project are predicted to increase by approximately 14 DNL. Along Mamalahoa Highway, traffic noise levels are predicted to increase by 4 DNL. Along Hina Lani Street, traffic noise levels are predicted to increase by 6.5 to 10.4 DNL. The range of increases in traffic noise levels from 0 to 4 DNL is considered to be low to moderate, since it represents the growth in forecasted project and non-project traffic in the project environs over a 24 year period. The range of increases from 6 to 14 DNL over a 24 year period is considered to be moderate to large.

Table 6 summarizes the predicted increases in the future setback distances to the 65 and 75 DNL traffic noise contour lines along the roadways in the project environs and attributable to both project plus non-project traffic in CY 2035. The setback distances in Table 6 do not include the beneficial effects of noise shielding from terrain features and highway cuts, or the detrimental effects of additive contributions of noise from intersecting streets. As indicated in Table 6, the setback distances to the 65 DNL contour are predicted to range from 338 to 354 FT from the centerline of Queen Kaahumanu Highway following project build-out in CY 2035. Along Mamalahoa Highway, setback distances to the 65 DNL contour are predicted to range from 145 to 151 FT from the centerline of Mamalahoa Highway. Along Hina Lani Street, setback distances to the 65 DNL contour are expected to range from 158 to 206 FT.

Table 8 presents the predicted increases in traffic noise levels associated with non-project and project traffic by CY 2035, and as measured by the DNL descriptor system. As indicated in Table 8, the increases in traffic noise along Queen Kaahumanu Highway due to project traffic are much greater than those resulting from non-project traffic. Along Mamalahoa Highway, project traffic noise contributions are expected to be much less than non-project traffic noise contributions by CY 2035. Along Hina Lani Street, project traffic is expected to increase traffic noise levels above those associated with non-project traffic by 4 to 7.5 DNL. The largest increases in traffic noise levels attributable to project traffic are expected to occur along Queen Kaahumanu Highway and Hina Lani Street. The relatively large increases in future traffic noise levels along Ane Keahokalole Highway are due to the relatively low non-project traffic volumes expected on that roadway by CY 2035.

TABLE 7A

FUTURE (CY 2035) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM PEAK HOUR, WITH PROJECT)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	50' Leq	100' Leq	200' Leq
Mamalahoa Hwy. - N. of Hina Lani St.	51	3,542	3,472	35	35	74.1	68.6	62.5
Mamalahoa Hwy. - S. of Hina Lani St.	50	3,452	3,382	35	35	73.8	68.3	62.2
Hina Lani St. - W. of Mamalahoa Hwy.	58	1,918	1,847	27	44	75.0	68.4	62.0
Hina Lani St. - E. of Ane Keahokalole Hwy.	55	2,738	2,637	44	57	75.8	69.2	62.8
Ane Keahokalole Hwy. - N. of Hina Lani St.	45	2,041	1,965	33	43	72.0	65.5	59.4
Ane Keahokalole Hwy. - S. of Hina Lani St.	45	1,613	1,553	26	34	70.9	64.5	58.4
Hina Lani St. - W. of Ane Keahokalole Hwy.	55	2,904	2,797	46	61	77.3	71.0	64.5
Hina Lani St. - E. of Kamanu St.	55	3,116	3,001	50	65	77.7	71.3	64.8
Hina Lani St. - W. of Kamanu St.	45	3,756	3,617	60	79	75.9	69.6	63.3
Hina Lani St. - E. of Q. Kaahumanu Hwy.	45	4,311	4,151	69	91	76.5	70.2	63.9
Kamanu St. - N. of Hina Lani St.	35	1,007	970	16	21	64.6	59.4	54.0
						100' Leq	200' Leq	300' Leq
Q. Kaahumanu Hwy. - N. of Hina Lani St.	58	4,250	4,003	119	128	78.2	75.2	67.3
Q. Kaahumanu Hwy. - S. of Hina Lani St.	58	5,279	4,973	148	158	79.1	76.1	68.2

TABLE 7B

FUTURE (CY 2035) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (PM PEAK HOUR, WITH PROJECT)

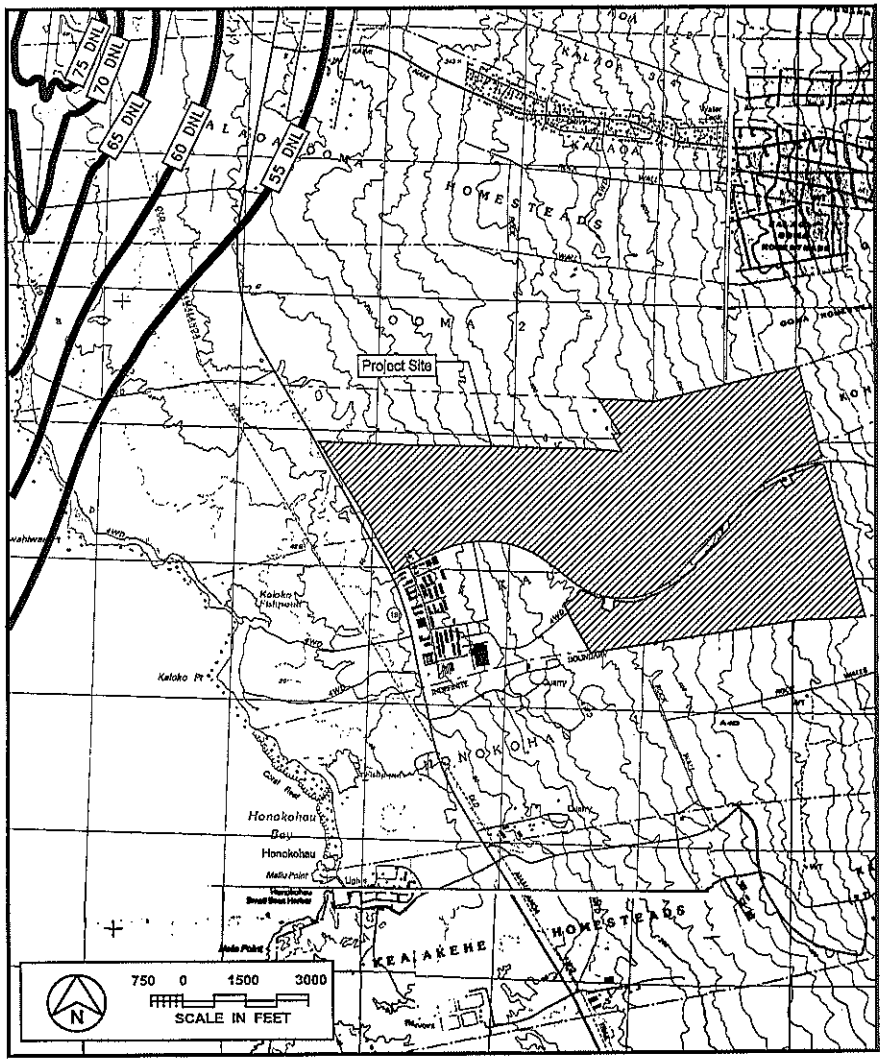
LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	50' Leq	100' Leq	200' Leq
Mamalahoa Hwy. - N. of Hina Lani St.	51	3,185	3,121	32	32	73.7	68.1	62.1
Mamalahoa Hwy. - S. of Hina Lani St.	50	2,980	2,920	30	30	73.1	67.6	61.5
Hina Lani St. - W. of Mamalahoa Hwy.	58	2,329	2,242	33	54	75.8	69.3	62.8
Hina Lani St. - E. of Ane Keahokalole Hwy.	55	3,332	3,209	53	70	76.6	70.1	63.7
Ane Keahokalole Hwy. - N. of Hina Lani St.	45	2,098	2,020	34	44	72.1	65.6	59.5
Ane Keahokalole Hwy. - S. of Hina Lani St.	45	1,915	1,844	31	40	71.7	65.2	59.1
Hina Lani St. - W. of Ane Keahokalole Hwy.	55	3,307	3,185	53	69	77.9	71.6	65.0
Hina Lani St. - E. of Kamanu St.	55	3,537	3,406	57	74	78.2	71.9	65.3
Hina Lani St. - W. of Kamanu St.	45	4,324	4,164	69	91	76.6	70.2	63.9
Hina Lani St. - E. of Q. Kaahumanu Hwy.	45	5,129	4,939	82	108	77.3	71.0	64.6
Kamanu St. - N. of Hina Lani St.	35	1,084	1,044	17	23	64.9	59.8	54.4
						100' Leq	200' Leq	300' Leq
Q. Kaahumanu Hwy. - N. of Hina Lani St.	49	5,113	5,026	72	15	75.8	72.7	64.7
Q. Kaahumanu Hwy. - S. of Hina Lani St.	49	6,484	6,374	91	19	76.8	73.8	65.7

TABLE 8

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2035)

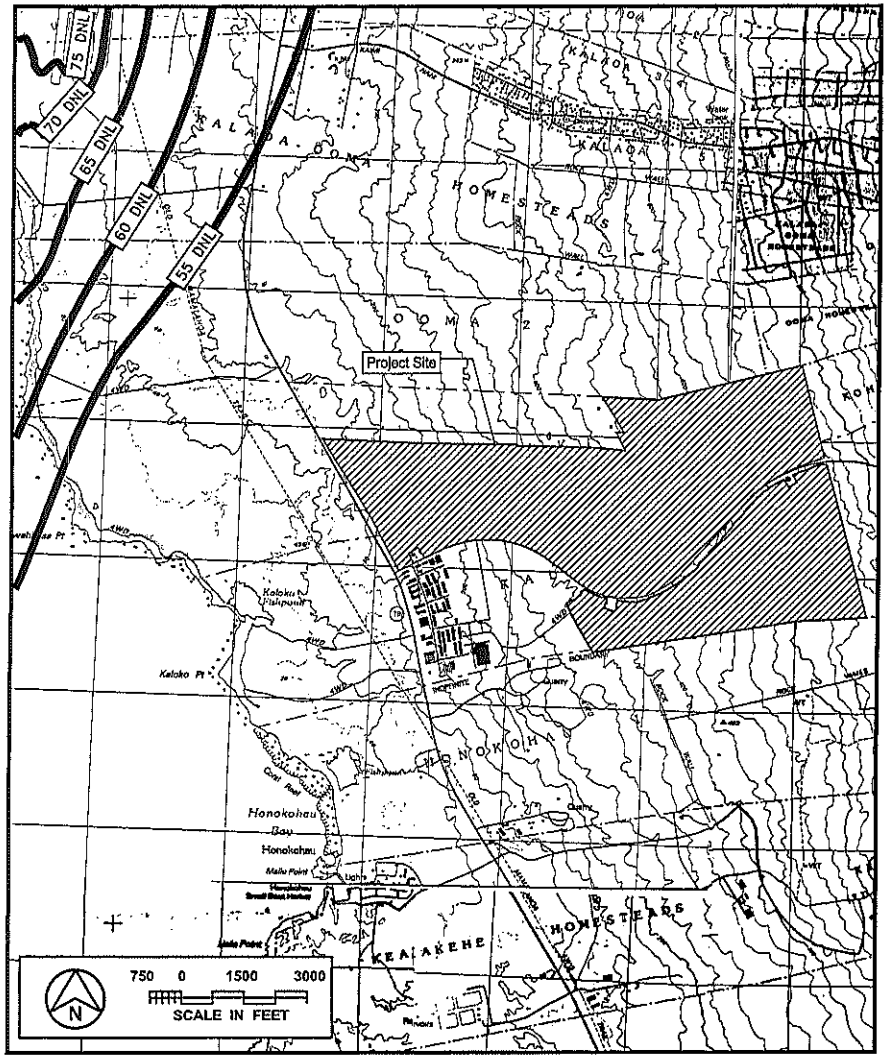
STREET SECTION	NOISE LEVEL (DNL) INCREASE DUE TO: NON-PROJECT TRAFFIC	PROJECT TRAFFIC
Mamalahoa Hwy. - N. of Hina Lani St.	3.2	0.8
Mamalahoa Hwy. - S. of Hina Lani St.	2.9	1.0
Hina Lani St. - W. of Mamalahoa Hwy.	2.5	4.0
Hina Lani St. - E. of Ane Keahokalole Hwy.	4.4	4.2
Ane Keahokalole Hwy. - N. of Hina Lani St.	49.2	16.4
Ane Keahokalole Hwy. - S. of Hina Lani St.	60.6	4.6
Hina Lani St. - W. of Ane Keahokalole Hwy.	3.7	6.4
Hina Lani St. - E. of Kamanu St.	3.0	7.4
Hina Lani St. - W. of Kamanu St.	2.4	7.5
Hina Lani St. - E. of Q. Kaahumanu Hwy.	1.2	6.0
Kamanu St. - N. of Hina Lani St.	N/A	59.8
Q. Kaahumanu Hwy. - N. of Hina Lani St.	3.3	10.5
Q. Kaahumanu Hwy. - S. of Hina Lani St.	2.8	11.3

Aircraft Noise. The aircraft noise contours in the project environs for the CY 2013 and 2030 periods were developed during the most recent 14 CFR Part 150 Noise Study Update for Kona International Airport at Keahole. These airport noise contours are shown in Figures 8 and 9 and were obtained from Reference 6. These noise contours and their relationships to the project site are very similar to the existing (2008) airport noise contours shown in Figure 7. The forecasted 2013 and long range airport noise contours are expected to remain outside the project area. Based on the relationships of the project site to the forecasted airport noise contours shown in Figures 8 and 9, it was concluded that risks of adverse noise impacts from aircraft noise should be minimal at the project site, and that the proposed noise sensitive developments on the project site conforms to the land use compatibility recommendations of the State Department of Transportation, Airports Division.



2013 14 CFR PART 150 NOISE CONTOURS FOR KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 8



LONG RANGE 14 CFR PART 150 NOISE CONTOURS FOR KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 9

CHAPTER VII. DISCUSSION OF PROJECT RELATED NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES

Traffic Noise. The increases in traffic noise levels attributable to the project from the present to CY 2035 are predicted to range from 10.5 to 11.3 DNL along Queen Kaahumanu Highway, where traffic noise levels are expected to be above 65 DNL at relatively large distances from the highway Right-of-Way. These increases in traffic noise levels along Queen Kaahumanu Highway which are attributable to the project are much higher than the traffic noise increases expected as a result of non-project traffic. The project's development plan has allowed for adequate setback distances of the project's noise sensitive parcels from Queen Kaahumanu Highway, with the commercial properties providing both a buffer and sound attenuating structures between the highway and the noise sensitive parcels planned to the east. The lands along the highway Right-of-Way are generally vacant in the project environs except for existing commercial developments south of the Hina Lani Street intersection. For these reasons, traffic noise impacts along Queen Kaahumanu Highway and resulting from project traffic are not considered to be serious. However, setback distances to the 65 and 75 DNL contours are expected to increase as a result of both project and non-project traffic.

Relatively small increases (1.0 DNL or less) in traffic noise levels along the north and south sections of Mamalahoa Highway at the Hina Lani Street intersection are expected to occur as a result of the proposed project. Non-project traffic is expected to cause increases of 2.9 to 3.2 DNL during this same period. By CY 2035, project traffic is expected to increase traffic noise levels along the north and south sections of Mamalahoa Highway by approximately 0.8 DNL and 1.0 DNL, respectively. This level of increase is not considered significant, and traffic noise impacts resulting from project traffic along these sections of the highway will be difficult to quantify over this 24 year period.

Along Hina Lani Street, potential noise impacts from project and non-project traffic are possible, both in respect to existing and planned noise sensitive receptors along this roadway. Existing and future residences which are located along the sections of Hina Lani Street between Mamalahoa Highway and Queen Kaahumanu Highway may be impacted by the future traffic noise along the roadway if their setback distances from the highway centerline are less than 206 FT. Because traffic noise along public roadways such as Hina Lani Street are generated by non-project as well as project traffic, mitigation of offsite traffic noise impacts are generally performed by individual property owners along the roadways' Rights-of-Way or by public agencies during roadway improvement projects. These mitigation measures generally take the form of increased setbacks, sound attenuating walls, total closure and air conditioning, or the use of sound attenuating windows. Where adequate setbacks beyond the 65 DNL noise contour are not available, the construction of 6 FT high sound walls is generally effective for attenuating traffic noise at single story structures, or at the ground floors of multistory structures. Whenever mitigation of traffic noise at the upper

floors are required, the use of closure and air conditioning, or the use of sound attenuating windows are the more appropriate sound attenuation measures. Along the future Ane Keahokalole Highway, project residences and school buildings will require setback distances in the order of 102 to 107 FT from the centerline of the highway, or sound attenuation walls constructed along the Rights-of-Way may be required for traffic noise mitigation.

Aircraft Noise. Based on currently available existing and forecasted aircraft noise contours over the project site, special aircraft noise attenuation measures are not considered mandatory on the project site. The implementation of the airport noise disclosure provisions of Act 208 is not required because the existing and forecasted 55 DNL noise contours do not enter into the project area.

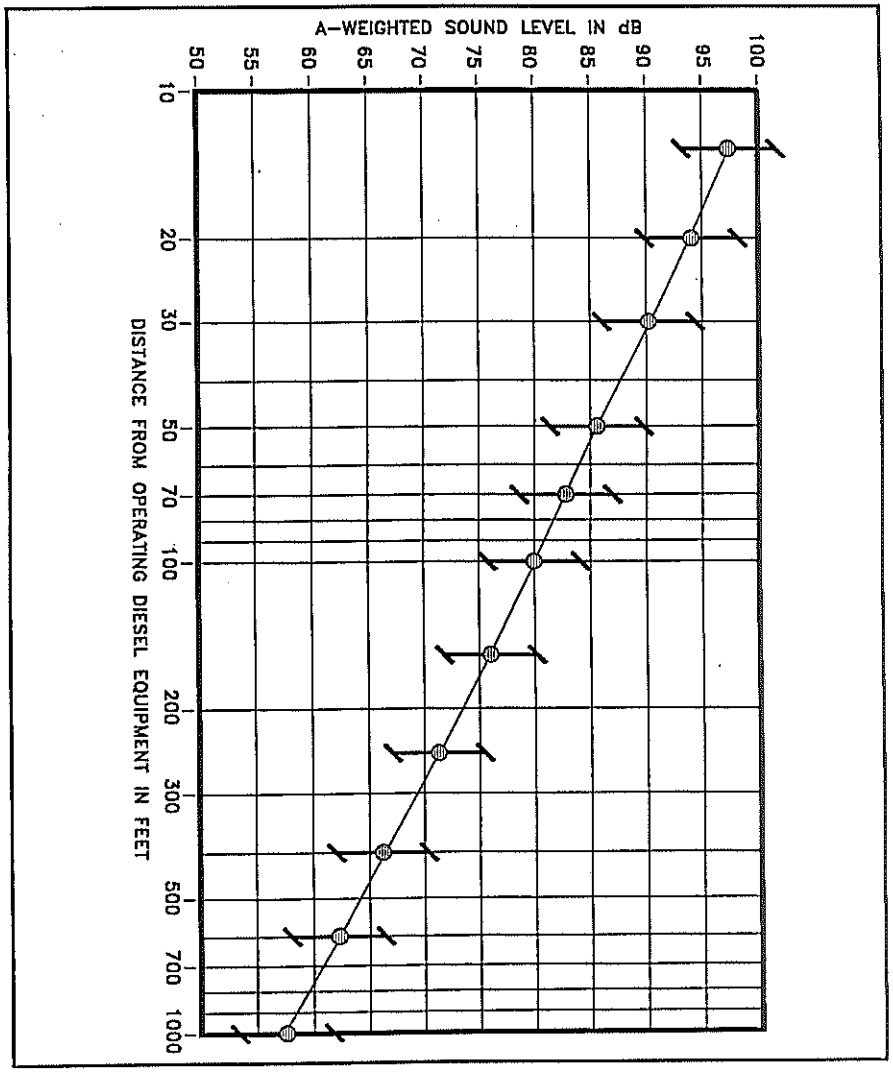
Combined Traffic and Aircraft Noise. When applying for FHA/HUD financial assistance on residential developments, sound attenuation measures are normally required if total exterior noise levels exceed 65 DNL. Traffic noise levels may exceed 65 DNL along the highway corridors and major thoroughfares which service the project. If the traffic noise level equals 65 DNL and the aircraft noise level is less than 55 DNL at a project dwelling, the total noise level will also be 65 DNL, which does not exceed the FHA/HUD standard of 65 DNL. Because existing and forecasted aircraft noise levels over the project site should not exceed 55 DNL, combined traffic and aircraft noise levels should not exceed 65 DNL when traffic noise levels are equal to or less than 65 DNL. Where traffic noise levels exceed 65 DNL, the combined noise levels will be identical to the traffic noise levels over the entire project site, and will not be dependent upon the levels of aircraft noise.

Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for construction is unknown, but it is anticipated that the actual work will be moving from one location on the project site to another during that period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Typical levels of noise from construction activity (excluding pile driving activity) are shown in Figure 10. The noise sensitive properties which are predicted to experience the highest noise levels during construction activities on the project site are the future residences who first occupy the project site following the initial phases of project completion. Existing residences to the east along Hina Lani Street may also experience audible construction noise of approximately 55 dBA or less. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work and due to the administrative controls available for its regulation. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

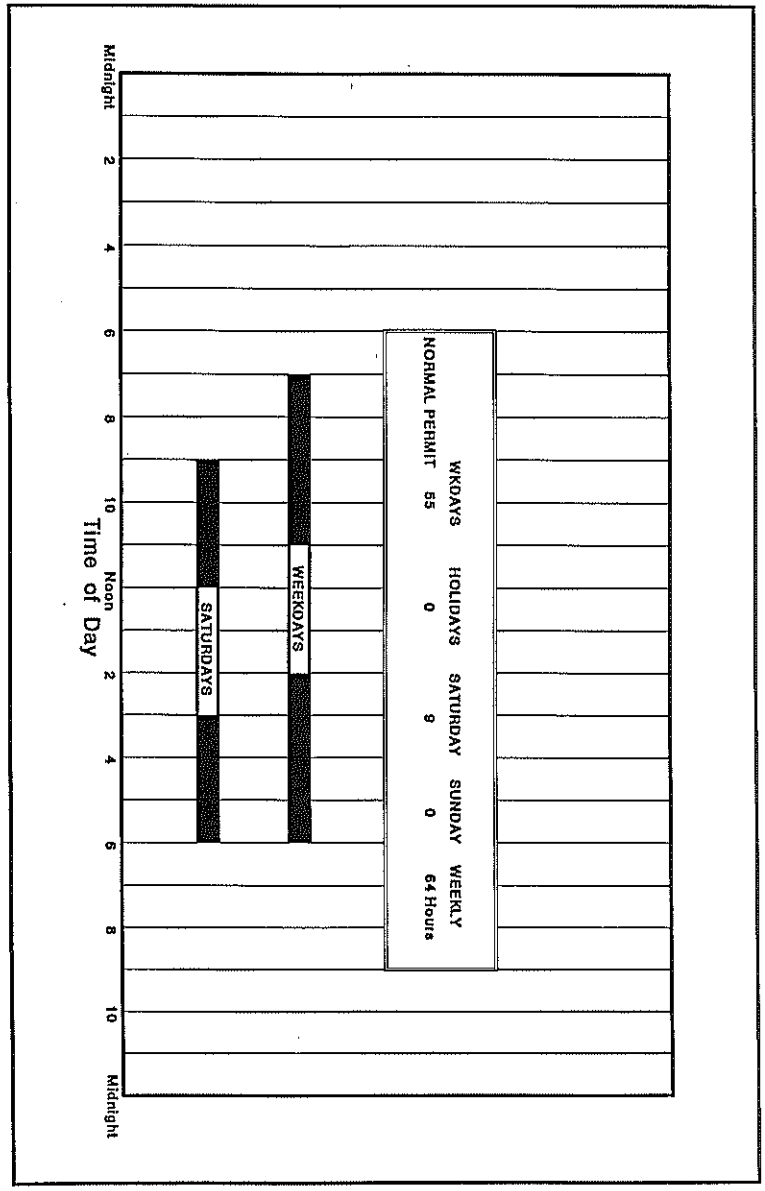
Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (grading and earth moving,

FIGURE 10

ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE



trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site. The incorporation of State Department of Health construction noise limits and curfew times, which are applicable on the island of Hawaii (Reference 7), is another noise mitigation measure which can be applied to this project. Figure 11 depicts the normally permitted hours of construction for normal construction noise as well as the curfew periods for construction noise. Noisy construction activities are not allowed on Sundays and holidays under the DOH permit procedures.



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 11

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June 1980.

(2) American National Standard, "Sound Level Descriptors for Determination of Compatible Land Use," ANSI S12.9-1998/ Part 5; Acoustical Society of America.

(3) "Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; July 12, 1979.

(4) "Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety;" U.S. Environmental Protection Agency; EPA 550/9-74- 004; March 1974.

(5) "Mandatory Seller Disclosures in Real Estate Transactions;" Chapter 508D, Hawaii Revised Statutes; July 1, 1996.

(6) "Kona International Airport At Keahole, 14 CFR Part 150 Noise Compatibility Study, Noise Exposure Maps Update;" State Department of Transportation, Airports Division; April 2009.

(7) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(8) "FHWA Highway Traffic Noise Model User's Guide;" FHWA-PD-96-009, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(9) Existing and Future Traffic Turning Movements for Kaloko Makai Project;" via email from Wilson Okamoto Corporation.; June 10, 2011.

(10) 24-Hour Traffic Counts, Station B71001909280, Queen Kaahumanu Highway Between OTEC Access Road and Hulikoa Street; State Department of Transportation; May 31, 2006.

APPENDIX B

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

TABLE I

A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

TERM	SYMBOL
1. A-Weighted Sound Level	L_A
2. A-Weighted Sound Power Level	L_{WA}
3. Maximum A-Weighted Sound Level	L_{max}
4. Peak A-Weighted Sound Level	L_{Apk}
5. Level Exceeded x% of the Time	L_x
6. Equivalent Sound Level	L_{eq}
7. Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8. Day Sound Level	L_d
9. Night Sound Level	L_n
10. Day-Night Sound Level	L_{dn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$
12. Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78,

TABLE II

RECOMMENDED DESCRIPTOR LIST

TERM	A-WEIGHTING	ALTERNATIVE(1) A-WEIGHTING	OTHER(2) WEIGHTING	UNWEIGHTED
1. Sound (Pressure)(3) Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2. Sound Power Level	L_{WA}		L_{WB}	L_W
3. Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4. Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5. Level Exceeded x% of the Time	L_x	L_{Ax}	L_{Bx}	L_{px}
6. Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7. Equivalent Sound Level (4) Over Time(T)	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8. Day Sound Level	L_d	L_{Ad}	L_{Bd}	L_{pd}
9. Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10. Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12. Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13. Energy Average Value Over (Non-Time Domain) Set of Observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14. Level Exceeded x% of the Total Set of (Non-Time Domain) Observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15. Average L_x Value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

APPENDIX C

SUMMARY OF BASE YEAR AND FUTURE YEAR TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2011 ***** AM VPH	PM VPH	CY 2035 (NO BUILD) AM VPH	PM VPH	CY 2035 (BUILD) AM VPH	PM VPH
Mamalahoa Hwy. - North of Hina Lani St. (NB)	331	701	690	1,510	964	1,834
Mamalahoa Hwy. - North of Hina Lani St. (SB)	1,087	477	2,267	1,043	2,578	1,351
Two-Way	1,418	1,178	2,957	2,553	3,542	3,185
Mamalahoa Hwy. - South of Hina Lani St. (NB)	393	588	732	1,203	1,074	1,542
Mamalahoa Hwy. - South of Hina Lani St. (SB)	1,035	601	2,076	1,081	2,378	1,438
Two-Way	1,428	1,189	2,808	2,284	3,452	2,980
Hina Lani St. - West of Mamalahoa Hwy. (EB)	136	400	228	673	804	1,354
Hina Lani St. - West of Mamalahoa Hwy. (WB)	250	163	461	328	1,114	975
Two-Way	386	563	689	1,001	1,918	2,329
Hina Lani St. - East of Ane Keahokalole Hwy. (EB)	101	339	245	903	1,002	1,968
Hina Lani St. - East of Ane Keahokalole Hwy. (WB)	220	160	679	462	1,736	1,364
Two-Way	321	499	924	1,365	2,738	3,332
Ane Keahokalole Hwy. - North of Hina Lani St. (NB)	N/A	N/A	29	23	1,211	974
Ane Keahokalole Hwy. - North of Hina Lani St. (SB)	N/A	N/A	38	29	830	1,124
Two-Way	N/A	N/A	67	52	2,041	2,098
Ane Keahokalole Hwy. - South of Hina Lani St. (NB)	N/A	N/A	302	361	863	911
Ane Keahokalole Hwy. - South of Hina Lani St. (SB)	N/A	N/A	270	414	750	1,004
Two-Way	N/A	N/A	572	775	1,613	1,915
Hina Lani St. - West of Ane Keahokalole Hwy. (EB)	101	339	224	825	1,219	1,927
Hina Lani St. - West of Ane Keahokalole Hwy. (WB)	220	160	699	337	1,685	1,380
Two-Way	321	499	923	1,162	2,904	3,307
Hina Lani St. - East of Kamanu St. (EB)	101	339	251	639	1,451	1,948
Hina Lani St. - East of Kamanu St. (WB)	220	160	504	351	1,665	1,589
Two-Way	321	499	755	990	3,116	3,537
Hina Lani St. - West of Kamanu St. (EB)	137	210	427	401	1,980	1,954
Hina Lani St. - West of Kamanu St. (WB)	232	439	397	754	1,776	2,370
Two-Way	369	649	824	1,155	3,756	4,324

APPENDIX C (CONTINUED)

SUMMARY OF BASE YEAR AND FUTURE YEAR TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2011 ***** AM VPH	PM VPH	CY 2035 (NO BUILD) AM VPH	PM VPH	CY 2035 (BUILD) AM VPH	PM VPH
Hina Lani St. - East of Q. Kaahumanu Hwy. (EB)	532	741	816	912	2,369	2,465
Hina Lani St. - East of Q. Kaahumanu Hwy. (WB)	415	744	563	1,048	1,942	2,664
Two-Way	947	1,485	1,379	1,960	4,311	5,129
Kamanu St. - North of Hina Lani St. (NB)	N/A	N/A	N/A	N/A	571	475
Kamanu St. - North of Hina Lani St. (SB)	N/A	N/A	N/A	N/A	436	609
Two-Way	N/A	N/A	N/A	N/A	1,007	1,084
Q. Kaahumanu Hwy. North of Hina Lani St. (NB)	670	859	1,425	1,929	1,993	2,575
Q. Kaahumanu Hwy. North of Hina Lani St. (SB)	839	918	1,648	1,897	2,257	2,538
Two-Way	1,509	1,777	3,073	3,826	4,250	5,113
Q. Kaahumanu Hwy. South of Hina Lani St. (NB)	845	1,111	1,601	2,051	2,721	3,161
Q. Kaahumanu Hwy. South of Hina Lani St. (SB)	897	1,173	1,571	2,155	2,558	3,323
Two-Way	1,742	2,284	3,172	4,206	5,279	6,484

Appendix O

Air Quality Study for the Proposed Kaloko Makai Project
B.D. Neal & Associates
July 2011

Draft

AIR QUALITY STUDY

FOR THE PROPOSED

KALOKO MAKAI VILLAGE PROJECT

NORTH KONA, HAWAII

Prepared for:

Sanford Carr Development

July 2011

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1	Summary of State of Hawaii and National Ambient Air Quality Standards
2	Air Pollution Emissions Inventory for Island of Hawaii, 1993

TABLES (cont.)

Table

3 Annual Summaries of Ambient Air Quality Measurements for Monitoring Stations Nearest Kaloko Makai Village Project

4 Estimated Worst-Case 1-Hour Carbon Monoxide Concentrations Along Roadways Near Kaloko Makai Village Project

5 Estimated Worst-Case 8-Hour Carbon Monoxide Concentrations Along Roadways Near Kaloko Makai Village Project

6 Estimated Indirect Air Pollution Emissions from Kaloko Makai Village Project Electrical Demand

1.0 SUMMARY

Sanford Carr Development is proposing to develop the Kaloko Makai Village Project in the North Kona District on the island of Hawaii. The proposed 900-acre project will include single and multi-family housing, a hotel, commercial space, two schools, parks and other associated amenities and facilities. Development of the project is expected to occur in three phases and be completed and fully occupied by 2035. 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, although in some cases the Hawaii standards are more stringent than the national standards, such as for carbon monoxide. For some other parameters, such as for particulate matter and sulfur dioxide, the national standards are more restrictive.

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 project area is very much affected

by its near coastal situation and by nearby mountains. Winds are predominantly light and variable, although kona storms generate occasional strong winds from the south or southwest during winter. Temperatures in the project area are generally very consistent and moderate with average daily temperatures ranging from about 65°F to 85°F. The extreme minimum temperature recorded at the nearby Old Kona Airport is 47°F, while the extreme maximum temperature is 93°F. Average annual rainfall in the area amounts to about 25 inches with each month typically contributing about 2 inches.

Except for periodic impacts from volcanic emissions (vog) and possibly occasional localized impacts from traffic congestion, the present air quality of the project area is believed to be relatively good. The limited air quality data that are available for the area from the Department of Health indicate that fine particulate concentrations, which are due to the vog, exceed the national air quality standards.

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 periods 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, a computerized air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at roadway intersections in the project vicinity and to predict future levels with 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 2035 with the project, carbon monoxide concentrations were predicted to increase in the project area, but concentrations should remain within state and federal standards. 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 significant impacts are unlikely. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts and conserve the island's resources.

2.0 INTRODUCTION

Sanford Carr Development is proposing to develop the Kaloko Makai Village Project on approximately 900 acres of undeveloped lands in the North Kona District on the island of Hawaii (see Figure 1 for project location). The project site straddles Hina Lani Street between Queen Kaahumanu Highway and Mamalahoa Highway. The proposed mixed-use development includes multi- and single-family housing, a hotel, parks, an elementary school, a middle school, hospital/medical facilities, commercial space for stores and services, office space, fire/police facilities, a wastewater treatment plant, light industrial space and other associated facilities and infrastructure. Development is planned for three phases. Full development and occupancy of the development is project for 2035.

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. On the other hand, the current Hawaii AAQS for sulfur dioxide are probably less stringent than the national standards. During the early part of 2010, the national primary annual and 24-hour standards for sulfur dioxide were revoked in favor of a new national 1-hour standard which is considered to be more stringent than the Hawaii short-term standards. The Hawaii AAQS for sulfur dioxide

have not yet been updated to bring them in line with the national standards.

In 1993, the state 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 as a result, the new standards for particulate were finally implemented during 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 that was the same as the national standard. During 2008, the national standard for ozone was again revised and made more stringent. The Hawaii standard for ozone has not yet been amended to follow the national standard.

During the latter part of 2008, EPA revised the standard for lead making the standard more stringent. So far, the Hawaii Department of Health has not revised the corresponding state standard for lead.

During early 2010, a national 1-hour primary standard for nitrogen dioxide was implemented. To date, Hawaii has not promulgated a 1-hour standard for nitrogen dioxide, but the

Hawaii annual standard for this pollutant is more stringent than the national annual standard.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, 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.

The site of the proposed project is located near the midpoint of the western coast of the island of Hawaii. The topography of Hawaii Island is dominated by the great volcanic masses of Mauna Loa (13,653 feet), Mauna Kea (13,796 feet), and of Hualalai, the Kohala Mountains and Kilauea. The island consists entirely of the slopes of these mountains and of the broad saddles between them. Mauna Loa and Kilauea, located on the southern half of the island, are still active volcanoes.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Nearly the entire western coast of the island of Hawaii, however, is sheltered from the trade winds by high mountains, except when unusually strong trade winds sweep through

the saddle between the Kohala Mountains and Mauna Kea and reach some areas to the lee. Due to wind shadow effects caused by the terrain, winds in the project area are predominantly light and variable. Local winds such as land/sea breezes and/or upslope/downslope winds dominate the wind pattern for the area. During the daytime, winds typically move onshore because of seabreeze and/or upslope effects. At night, winds generally are land breezes and/or drainage winds that move downslope and out to sea. During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's leeward location results in a larger temperature profile compared to windward locations at the same elevation. At the Old Kona Airport, located a few miles south of the project site, average daily minimum and maximum temperatures are 67°F and 83°F, respectively [1]. The extreme

minimum temperature on record at this location is 47°F, and the extreme maximum is 93°F. Temperatures at the project site are 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 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Kona area, stability classes 5 or 6 typically occur during the 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 climate of the project area is wetter than might be expected for a leeward location. This is due to the persistent onshore and upslope movement of marine air caused by both eddie and seabreeze or mountain slope effects. Some of the rainfall occurs during summer afternoons and evenings as a result of this onshore and upslope movement of moisture-laden marine air, and some occurs in conjunction with winter storms. At the Old Kona Airport, average annual rainfall amounts to about 25 inches with each month registering about 2 inches [1]. Rainfall at the project site is probably about the same.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Table 2 presents an air pollutant emission summary for the island of Hawaii for calendar year 1993. This has become

somewhat dated but is the latest information available. 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 manmade particulate emissions on Hawaii originate from area sources, such as the mineral products industry and agriculture. Manmade sulfur oxides are emitted almost exclusively by point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions emanate predominantly from area sources (mostly motor vehicle traffic), although industrial point sources 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. Based on previous emission inventories that have been reported for Hawaii, emissions of particulate and nitrogen oxides may have increased during the past several years, while emissions of sulfur oxides, carbon monoxide and hydrocarbons probably have declined.

It should be noted that Hawaii Island is unique from the other islands in the state in terms of the natural volcanic air pollution emissions that occur. Volcanic emissions periodically plague the project area. This is especially so since the latest eruption phase of the Kilauea Volcano began in 1983. Air pollution emissions from the Hawaiian volcanoes consist primarily of sulfur dioxide. After entering the atmosphere, these sulfur dioxide emissions are carried away by the wind and either washed out as acid rain or gradually transformed into particulate sulfates or acid aerosols. Although emissions from Kilauea are vented on the other side of a mountain barrier more than 50 miles east of the project site, the prevailing wind patterns eventually

carry some of the emissions into the Kona area. These emissions can be seen in the form of the volcanic haze (vog) which persistently hangs over the area.

The major industrial source of air pollution in the project vicinity is Hawaii Electric Light Company's Keahole Power Plant, which is located about 2 miles to the north. Air pollution emissions from Keahole Power Plant consist mostly of sulfur dioxide and oxides of nitrogen.

The project site is situated between Queen Kaahumanu Highway on the makai side and Mamalahoa Highway on the mauka side. Both of these highways are regional arterial roadways that often carry substantial volumes of traffic. Winds may sometimes carry emissions from motor vehicles traversing these roadways toward the project site.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state. Unfortunately, very limited data are available for Hawaii Island, and even less data are available for the Kona area specifically. During the most recent 5-year period for which data have been reported (2005-2009), the Department of Health operated an air quality monitoring site in the Kealakekua area for measuring sulfur dioxide. Particulate (PM 2.5) was also monitored at this site, but monitoring for this parameter was only initiated during 2008. As indicated in Table 3, measurements of sulfur dioxide concentrations at this location during the 2005-2009 monitoring

period were consistently low with annual average concentrations of 0.004 to 0.005 ppm, which represents about 15 percent of the state and national standard. The highest annual second-highest 3-hour and 24-hour concentrations (which are most relevant to the standards) for these five years were 0.112 and 0.042 ppm, respectively; these are about 22 to 30 percent of the applicable standards. No exceedances of the state/national 3-hour and 24-hour AAQS for sulfur dioxide were recorded.

The annual average particulate (PM 2.5) concentrations for the years 2008 and 2009 were 21 and 16 $\mu g/m^3$, respectively. These values exceed the national annual standard which is set at 15 $\mu g/m^3$. The 98th percentile 24-hour concentration (which is most relevant to the national 24-hour standard) was reported at 37 $\mu g/m^3$ for both 2008 and 2009. This is slightly above the national standard of 35 $\mu g/m^3$. These higher concentrations of fine particulate are primarily due to volcanic emissions.

At this time, there are no reported measurements of lead, ozone, nitrogen dioxide or carbon monoxide in the project vicinity. These are primarily motor vehicle related air pollutants. Lead, ozone and nitrogen dioxide typically are regional scale problems. Concentrations of lead and nitrogen dioxide generally have not been found to exceed AAQS elsewhere in the state. Ozone concentrations, on the other hand, have been found to exceed the state standard at times at Sand Island on Oahu. Carbon monoxide air pollution typically is a microscale problem caused by congested motor vehicular traffic. In traffic congested areas

such as urban Honolulu, carbon monoxide concentrations have been found to occasionally exceed the state AAQS. Present concentrations of carbon monoxide in the project area are estimated later in this study based on computer modeling of motor vehicle emissions.

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 annual standard for nitrogen dioxide is not likely to be violated by short-term construction equipment emissions. Also, the new short-term (1-hour) standard for nitrogen dioxide is based on a three-year average; thus it is unlikely that relatively short-term construction emissions would exceed the standard. Carbon monoxide emissions from diesel engines 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 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, two scenarios were selected for the carbon monoxide modeling study: year 2011 with present conditions and year 2035 with the project. To begin the modeling study of the two 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, several of the key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Queen Kaahumanu Highway at Hulikoa Drive
- Queen Kaahumanu Highway at Kaiminani Drive
- Queen Kaahumanu Highway at Hina Lani Street
- Queen Kaahumanu Highway at Kealakehe Parkway
- Hina Lani Street at Kamanu Street
- Hina Lani Street at Mamalahoa Highway
- Hina Lani Street at Ane Keohokalole Highway (future)

The traffic impact report for the project [4] describes the projected future traffic conditions and laneage configurations of these 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 two 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 MOBILE6.2 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6.2 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 34.2% light-duty gasoline-powered automobiles, 52.8% light-duty gasoline-powered trucks and

vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.6% 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 MOBILE6.2 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6.2, 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.

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. All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6.2 based on assumed free-flow vehicle speeds corresponding to the posted speed limits.

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 2011. Although increased traffic is expected to occur within the project area during 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 scenario studied.

Predicted Worst-Case 1-Hour Concentrations

Table 4 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 two scenarios: year 2011 with existing traffic and year 2035 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 (2011) case was 4.0 ppm. This was projected to occur during the morning peak traffic hour near the intersection of Queen Kaahumanu Highway and Kealakehe Parkway. Concentrations at other locations and times studied were 2.9 ppm or lower. All predicted worst-case 1-hour concentrations for the 2011 scenario were within both the national AAQS of 35 ppm and the state standard of 9 ppm.

In the year 2035 with the proposed project, the predicted highest worst-case 1-hour concentration continued to occur during the morning at the intersection of Queen Kaahumanu Highway and Kealakehe Parkway with a value of 7.1 ppm. Other concentrations for this scenario ranged between 2.8 and 5.2 ppm. With the project and assuming the roadway improvements identified in the

project traffic study are implemented, carbon monoxide concentrations were predicted to increase compared to the existing case at all locations studied. However, the predicted worst case carbon monoxide concentrations remained 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 5. For the 2011 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the six locations studied ranged from 0.8 ppm at the Hina Lani Street at Kamanu Street intersection to 3.6 ppm at the Queen Kaahumanu Highway/Kealakehe Parkway intersection. The estimated worst-case concentrations for the existing case were well within the national limit of 9 ppm and the state standard of 4.4 ppm.

For the 2035 with project scenario, worst-case concentrations increased at all locations studied compared to the existing case. The worst-case concentrations ranged from 2.2 to 3.6 ppm. Although concentrations were predicted to increase compared to the existing case, all predicted 8-hour concentrations for the 2035 with project 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 a maximum of approximately 204 million kilowatt-hours [12]. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities, but some of the project power may also be derived from geothermal energy, wind power or other sources. In order to meet the electrical power needs of the proposed project, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 6 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated indirect emissions from project electrical demand amount to about 5 percent or less of the present (manmade) air pollution emissions occurring on Hawaii Island if all power is assumed to be derived from oil.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 13,000 tons per year [12]. Currently, all solid waste on the island is buried at solid waste landfills. 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

Existing air quality in the project area is impacted by emissions from Kilauea Volcano. Fine particulate measurements from the Department of Health monitoring station at Kealakekua indicate that the national standards for both the 24-hour and the annual averaging periods may be exceeded. While this phase of Kilauea's eruption has been occurring for more than 25 years and it is unknown when it will end, fine particulate concentrations will go down significantly when it does.

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction phases. 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 construction of the proposed project is completed and it is fully occupied, carbon monoxide concentrations in the project area due to motor vehicle emissions will likely increase, but

worst-case concentrations 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 solid waste materials generated by the project will likely be small based on the relatively small magnitudes of these emissions. Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; 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; providing movable, controlled openings for ventilation at opportune times; and possibly installing 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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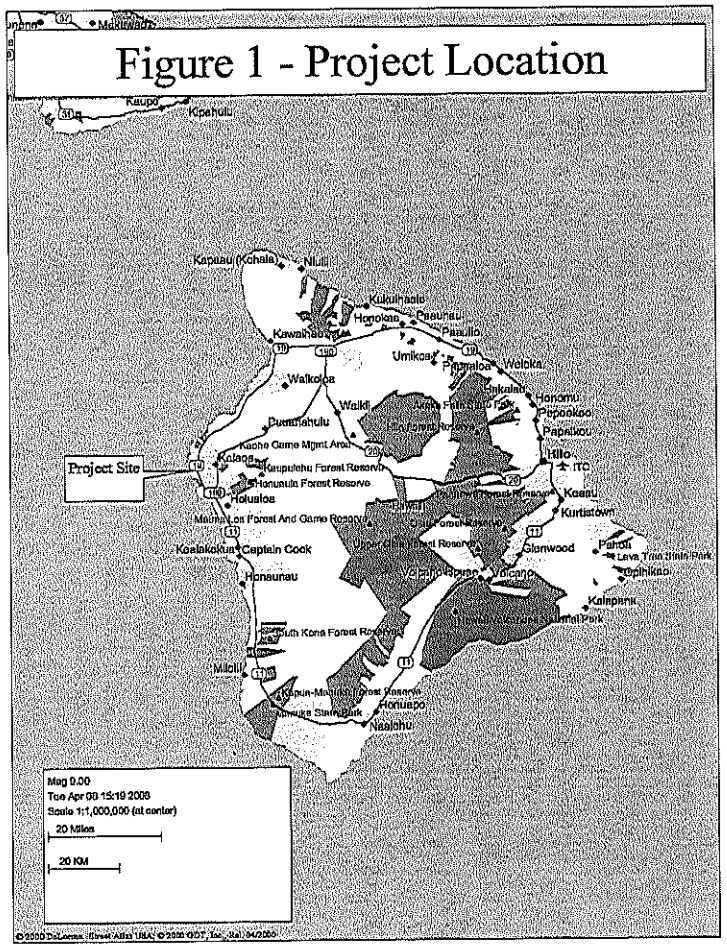

Figure 1 - Project Location

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)	$\mu g/m^3$	Annual	–	–	50
		24 Hours	150[a]	150[a]	150[b]
Particulate Matter (<2.5 microns)	$\mu g/m^3$	Annual	15[c]	15[c]	–
		24 Hours	35[d]	35[d]	–
Sulfur Dioxide	ppm	Annual	–	–	0.03
		24 Hours	–	–	0.14[b]
		3 Hours	–	0.5[b]	0.5[b]
		1 Hour	0.075[e]	–	–
Nitrogen Dioxide	ppm	Annual	0.053	0.053	0.04
		1 Hour	0.100[f]	–	–
Carbon Monoxide	ppm	8 Hours	9[b]	–	4.4[b]
		1 Hour	35[b]	–	9[b]
Ozone	ppm	8 Hours	0.075[g]	0.075[g]	0.08[g]
Lead	$\mu g/m^3$	3 Months	0.15[h]	0.15[h]	–
		Quarter	1.5[i]	1.5[i]	1.5[i]
Hydrogen Sulfide	ppm	1 Hour	–	–	35[b]

[a] Not to be exceeded more than once per year on average over three years.
[b] Not to be exceeded more than once per year.
[c] Three-year average of the weighted annual arithmetic mean.
[d] 98th percentile value of the 24-hour concentrations averaged over three years.
[e] Three-year average of annual fourth-highest daily 1-hour maximum.
[f] 98th percentile value of the daily 1-hour maximum averaged over three years.
[g] Three-year average of annual fourth-highest daily 8-hour maximum.
[h] Rolling 3-month average.
[i] Quarterly average.

Table 2

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF HAWAII, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	30,311	9,157	39,468
Sulfur Oxides	9,345	nil	9,345
Nitrogen Oxides	4,054	8,858	12,912
Carbon Monoxide	3,357	23,934	27,291
Hydrocarbons	1,477	203	1,680

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 3

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR
MONITORING STATIONS NEAREST KALOKO MAKAI VILLAGE PROJECT

Parameter / Location	2005	2006	2007	2008	2009
Sulfur Dioxide / Kealakekua, Kona					
3-Hour Averaging Period:					
No. of Samples	2341	2697	2756	2445	2560
Highest Concentration (ppm)	0.032	0.046	0.034	0.124	0.130
2nd Highest Concentration (ppm)	0.032	0.035	0.025	0.112	0.111
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	296	341	343	353	365
Highest Concentration (ppm)	0.018	0.012	0.011	0.054	0.045
2nd Highest Concentration (ppm)	0.016	0.011	0.011	0.038	0.042
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration (ppm)	0.005	0.004	0.004	0.009	0.004
Particulate (PM-2.5) / Kealakekua, Kona					
24-Hour Averaging Period:					
No. of Samples	-	-	-	292	352
Highest Concentration ($\mu g/m^3$)	-	-	-	44	61
98th Percentile Concentration ($\mu g/m^3$)	-	-	-	37	37
No. Occurrences Greater than 35 $\mu g/m^3$	-	-	-	10	8
Annual Average Concentration ($\mu g/m^3$)	-	-	-	21	16

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2005 – 2009"

Table 4

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR KALOKO MAKAI VILLAGE PROJECT
(parts per million)

Roadway Intersection	Year/Scenario			
	2011/Present		2035/With Project[a]	
	AM	PM	AM	PM
Queen Kaahumanu Highway at Hulikoa Drive	2.9	1.9	5.2	3.6
Queen Kaahumanu Highway at Kaiminani Drive	2.7	1.9	4.4	3.0
Queen Kaahumanu Highway at Hina Lani Street	2.9	2.7	-	-
Queen Kaahumanu Highway at Kealakehe Parkway	4.0	2.4	7.1	4.5
Hina Lani Street at Kamanu Street	1.4	1.5	4.8	3.7
Hina Lani Street at Mamalahoa Highway	2.3	1.2	5.1	2.8
Hina Lani Street at Ane Keohokalole Highway	-	-	4.9	3.2

Hawaii State AAQS: 9
National AAQS: 35

[a]Assumes roadway improvements shown in project traffic study

Table 5

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR KALOKO MAKAI VILLAGE PROJECT (parts per million)

Roadway Intersection	Year/Scenario	
	2011/Present	2035/With Project[a]
Queen Kaahumanu Highway at Hulikoa Drive	1.4	2.6
Queen Kaahumanu Highway at Kaiminani Drive	1.4	2.2
Queen Kaahumanu Highway at Hina Lani Street	1.4	-
Queen Kaahumanu Highway at Kealakehe Parkway	2.0	3.6
Hina Lani Street at Kamanu Street	0.8	2.4
Hina Lani Street at Mamalahoa Highway	1.2	2.6
Hina Lani Street at Ane Keohokalole Highway	-	2.4

Hawaii State AAQS: 4.4
National AAQS: 9

[a]Assumes roadway improvements shown in traffic study

Table 6

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM KALOKO MAKAI VILLAGE PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	52
Sulfur Dioxide	529
Carbon Monoxide	52
Volatile Organics	1
Nitrogen Oxides	227

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes demand of 204 million kw-hrs per year of electrical power use. Estimated emission rates assume low-sulfur oil used to generate power.

Appendix P

Economic and Fiscal Impact Assessment for Kaloko Makai
Mikiko Corporation
July 2011

MIKIKO CORPORATION

ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR KALOKO MAKAI

North Kona, Island of Hawaii

Prepared for:
SCD-TSA Kaloko Makai, LLC

FINAL REPORT

July 2011

Economic and Fiscal Impact Assessment for Kaloko Makai

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ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR KALOKO MAKAI

Report Text

1 – Introduction and Study Overview

Report Organization

This report is organized as follows:

- **Introduction and Study Overview** (Chapter 1) - Study background, objectives and approach of an economic and fiscal impact assessment prepared for the proposed Kaloko Makai community on the Island of Hawaii.
- **Executive Summary** (Chapter 2) – Tabular and narrative presentation of the most important findings of the study.
  - Projected Development Phasing
  - Projected Impacts
- **Study Conditions and Terminology** (Chapter 3) - Explanation of factors that underlie the above conclusions, presented in narrative form, including:
  - Special Considerations
  - Definition of Key Terms
  - Report Conditions
- **Exhibits** - Detailed study findings, showing detailed input assumptions and explanations in exhibit format.
- **Appendix** – Selected results of the State's econometric Input-Output model.

Project and Study Background

SCD-TSA Kaloko Makai, LLC (SCD-TSA) proposes to develop a 1,139-acre site in North Kona, Hawaii as a master-planned community called Kaloko Makai (the Project.) The site is well-situated in a rapidly developing area, south of Kona International Airport at Keahole (Kona Airport) and adjacent to and north of the well-established commercial and light industrial-service centers of North Kona and Kailua-Kona.

Kaloko Makai is planned as a Transit-Oriented Development (TOD), as identified in the Kona Community Development Plan (Kona CDP.) It would be one of 10 TOD areas identified by the County and community groups as a higher density area in which most of the future population growth of the Kona area is intended to be accommodated. The Project master plan includes the key elements shown on the following table.

Key Developments Proposed at Kaloko Makai

	Units	Notes
Residential units	5,000 homes	Affordable & market-priced, single- and multifamily
Commercial retail & office	1,100,000 sq. ft. GLA	May include medical office buildings if hospital is developed
Light industrial/ business park	75 (later 50) gross acres 40 net in 2040	75 acres initially, of which 25 are anticipated to be subsequently "taken" for a highway interchange
Lodge and business center	120 rooms and business center	Kama`aina and business traveler orientation
Outpatient care center	29,500 building sq. ft.	Includes pharmacy imaging, lab, ambulatory surgery & urgent care facilities
Skilled nursing facility (SNF)	150 SNF beds 82,500 sq. ft.	Offering skilled nursing and long-term care
Hospital	150 beds 286,000 sq. ft	Area includes service building; first increment proposed to open in second phase
Judiciary complex*	(Proposed by State of Hawaii)	Potential location for new State facility
Schools*	(To be developed by State of Hawaii)	One middle and two elementary school sites to be provided within the community

* Facilities planned or proposed for development, but not assessed in terms of their economic and fiscal impacts.

Source: SCD-TSA Kaloko Makai, LLC, 2011

The Project land use plan is presented in the Exhibits section as Exhibit 1-1.

Together, the proposed developments would create a substantial residential, civic and employment center, generating myriad opportunities for community life as well as employment in professional, business, service and retail fields for island residents.

Assuming that necessary entitlements (see next section, below) are obtained in a timely fashion, SCD-TSA estimates the first real estate products could be available by 2015 and that development could be completed by 2040.

Study Objectives

SCD-TSA seeks State of Hawaii (State) and County of Hawaii (County) entitlements for the Project, including a State Land Use District Boundary Amendment (SLUDBA), and County zoning. In this respect, SCD-TSA engaged Mikiko Corporation (Mikiko) to prepare two reports:

1) **Market assessment** – Mikiko prepared an assessment of the market support for the residential, commercial, industrial and lodge/business center uses proposed. Market assessments for the medical facilities were prepared by Cattaneo & Stroud, Inc.

2) **Economic and fiscal impact assessment** – Mikiko prepared this assessment of the economic and fiscal impacts of the Project, including its medical-related uses.

Mikiko's market assessment (herein "the Market Study") is contained in a separate document entitled "Market Assessment for Kaloko Makai," dated May 2011. The economic and fiscal impact assessment reported in this document uses findings from the Mikiko and the Cattaneo & Stroud market studies as input assumptions.

Factors that are Assessed

This economic and fiscal assessment assesses the Project's impacts within the State of Hawaii and the County of Hawaii. Factors evaluated include:

- Economic impacts:
  - Expenditures by persons attracted to reside on Island of Hawaii;
  - Development-related employment;
  - Operations-related employment; and
  - Personal income deriving from development and operations.
- Population impacts:
  - Residential utilization patterns;
  - Average daily visitor population; and
  - In-migrant resident population.
- Fiscal impacts:
  - Property tax and other County government revenues;
  - General excise tax, income tax, transient accommodations tax and other State government revenues;
  - County and State government operating expenditures; and
  - County and State net fiscal operating impacts.

Dollar Denomination

Unless otherwise stated, all dollar amounts in this report are stated in 2011 dollars.

Reporting Periods

This analysis extends from late 2012 to late 2040, a 28-year period that would span from preconstruction planning through Project buildout. The benchmark dates of analysis are defined to occur from "late" in each year because the developer and its consultants estimate that entitlements might be obtained late in 2012, and the State Land Use Commission (LUC) is particularly interested in the first 10 years thereafter.

Therefore, the reporting periods in which impacts are assessed are:

- **2012-2022** – A 10-year period beginning late in 2012 and extending to late 2022;
- **2022-2032** - A 10-year period beginning late in 2022 and extending to late 2032;
- **2032-2040** – An 8-year period beginning late in 2032 and extending to late 2040; and
- **After 2040** – An indefinite time beginning after complete buildout and market absorption of the project in late 2040. This final reporting "period" depicts the long-term impacts of the Project after its initial development and marketing impacts have been completed.

2 –Executive Summary

Projected Development Phasing

Kaloko Makai's first properties could be expected to be available for sale or lease in 2015. The Project is expected to be built out and sold out or leased-up by late 2040.

In accordance with current County policies, 700 residential units are expected to be priced to County standards for affordable housing. Affordable housing would be developed for sale at prices to be determined in agreements with governing agencies.[1]

Kaloko Makai is estimated to support some $2.17 billion in development-related expenditures statewide between late 2012 and late 2040. In an average year, this would represent $77 million in new expenditures.

This estimate includes infrastructure, vertical construction, commercial tenant improvements, landscaping and soft costs such as professional services, administration of operating subsidiaries and the like.

The cost estimate does not cover construction of the schools and proposed judiciary center, since such State projects are anticipated to be developed somewhere on the island, whether or not Kaloko Makai proceeds. Also excluded from this estimate are substantial sums that will be spent for furniture, fixtures and equipment within the various facilities and parks, County and State permits and fees, financing expenditures, insurance, contingency allowances and various other "soft costs." Portions of these substantial additional expenditures would also circulate through the local economies.

[1] Estimated affordable unit count is based on 5,000 total units generating 1,000 affordable housing credits, and County rules regarding assignment of credits on for-sale units by income range of buyers. See Hawaii County Code, Chapter 11, Section 11-5 (amended 2011.) If additional housing credits are required to address nonresidential units at Kaloko Makai, the developer will comply with such requirements.

For illustrative purposes, Hawaii County guidelines in effect as of September 1, 2010 would specify for-sale housing offered to households of two to four persons earning incomes ranging from less than 80% and up to 120% of the County median income be priced from $202,500 to $366,200; figure shown is based on a mix of market orientations that would satisfy the 1,000 credits expected to be required of the developer.

Alternatively, some of SCD-TSA's affordable housing commitment at the Project could be met with rental housing.

Overview of Proposed Developments and Costs
2011 dollars

	Comment	2012 - 2022	2022 - 2032	2032 - 2040	Total
Homes:	*Overall mix:*				
Market units	*86%*	1,469	1,726	1,105	4,300
Affordable units	*14%*	350	220	130	700
Total	*100%*	1,819	1,946	1,235	5,000
Average home sales price:					
Market units		$382,400	$382,400	$382,400	
Affordable units		$284,500	$284,500	$284,500	
Weighted average		$369,000	$369,000	$369,000	
Commercial uses:					
Light industrial land*	*Net acres*	20	12	8	40
Light industrial buildings	*Same area, but in building sq. ft.*	90,000	90,000	80,000	260,000
Retail & office centers	*Gross leasable area, in sq. ft.*	630,000	370,000	100,000	1,100,000
Lodge & Business Center	Guest rooms	0	120	0	120
Medical facilities -	Building square feet				
Outpatient care center		24,000	0	6,000	30,000
Hospital		0	191,000	95,000	286,000
Skilled nursing/long-term care		33,000	27,000	23,000	83,000
Total development costs**	*Hard and soft costs (mils)*	$761	$898	$511	$2,169
Average annual		$76	$90	$64	$77

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Kaloko Makai is also planned to include one middle and two elementary schools, and is proposed to house the State's proposed new judiciary center complex. These public facilities are not assessed herein.

* A 25 acre area alongside Queen Kaahumanu Highway is assumed to be taken by the State Department of Transportation for use as a highway interchange between 2022 and 2032.

** Includes professional services post-entitlement; vertical, horizontal and infrastructure construction costs; and various off-site costs such as home office overhead and developer's estimated contribution to extension of Ane Keohokalole Highway. The estimate does not include any of the following: furniture, fixtures and equipment costs, County and State permits and fees to be paid, budget contingencies, financing and insurance costs.

Projected Impacts

The Project would generate significant, on-going economic and fiscal benefits for residents of Hawaii, as well as for the County and State governments. Development of facilities would generate employment and consequent income and taxes. In addition, by attracting new residents to the Island of Hawaii and generating additional real estate sales activity, the Project is expected to support long-term impacts, including additional consumer expenditures, employment opportunities, personal income and government revenue enhancement.

Highlights of the Project impacts are summarized in the table on the next page.

Study methodology and definition of key terms such as "direct," "indirect" and "induced" are provided in Chapter 3.

Development Employment

- **FTE employment** – During its first 20 years, Kaloko Makai's development is estimated to generate employment for some 1,000 to 1,200 full-time equivalent (FTE) persons annually, including positions created directly and indirectly by its development activities. In the final 8 years of the Project's buildout, after most of its major infrastructure would have been completed, Kaloko Makai is expected to support some 800 FTE development-related jobs per year.

  All of these jobs would be located throughout the state, with greatest concentration on the Big Island.

- **Personal earnings** - The new development-related positions are expected to be associated with total personal earnings[3] of some $1.66 billion over the projection period, or $49 to $68 million per year. The earnings represent an average of about $58,000 per FTE job, including direct construction-related jobs as well as indirect and induced opportunities created throughout the economy.

[3] Earnings are defined as wage, salary and proprietary income, plus director's fees and employer contributions to health insurance, less employee contributions to social insurance.

Summary of Projected Economic and Fiscal Impacts
2011 dollars

	Comment	2022	2032	2040	After 2040
FTE employment:*	***Direct, indirect and induced except as noted***				
Development-related	*Average annual since prior date*	1,000	1,200	800	0
Operations-related - On-site	*Annual, on-going* *Generated at Project facilities (direct impacts only)*	1,800	3,400	4,200	4,200
Net new jobs on Island	*New to County*	600	1,700	2,400	2,300
Total personal earnings:**	***Direct, indirect and induced***				
Development-related	*Average annual since prior date*	$59	$68	$49	$0
Operations-related	*Annual, on-going, on net new jobs only*	$28	$86	$119	$115
Average earnings per FTE job:**	***Direct, indirect and induced (not in millions)***				
Development-related	*Average annual since prior date*	$58,000	$58,000	$58,000	NA
Operations-related	*On net new jobs only*	$47,000	$50,000	$50,000	$50,000
In-migrant resident population:	***Average daily employees, dependents, and new island residents***				
To the County		360	790	1,050	1,040
To the State	*Subset of County in-migrants*	280	600	800	780
Net additional government revenues:	***Projected revenues less projected expenditures***				
For the County		$5.1	$9.1	$10.8	$10.8
For the State		$5.6	$8.7	$8.4	$4.1
Revenue/expenditure ratio:					
For the County		8.6	6.6	6.1	6.1
For the State		4.6	3.6	2.9	2.0

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year. For construction- related impacts, figures shown refer to average annual since prior date shown (or Project commencement.)

Estimates do not consider impacts of the proposed Judiciary Center or planned schools, since equivalent facilities would be assumed to be developed elsewhere on the island even if the Project was not developed.

* FTE = Full-time equivalent, defined as 40 hours per week or 2,080 hours per year.

** Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

Sources: SCD-TSA Kaloko Makai, LLC, 2011; Cattaneo & Stroud, 2011; Mikiko Corporation, 2011.

Operational Employment

- **On-site jobs** - By the time of its expected completion in 2040, the Project could be expected to have generated some 4,200 direct FTE jobs on-site at its retail, office, industrial, lodge, and medical-related facilities. Because these on-site jobs would all be supported at Project components, they are all direct impacts; there are assumed to be no indirect or induced employment impacts on-site.

  This estimate does not include employees of the State's proposed new judiciary center, the three planned schools, Realtors and brokers that may locate on-site, private household workers or employees of community associations or facilities.

- **Net new jobs** –

  - **FTE employment** - Considering the Project's direct, indirect and induced impacts statewide, Kaloko Makai could alternatively be seen to have generated some 2,300 permanent, on-going FTE jobs. These are positions that might not have existed had the Project not been developed. These "net new" jobs could include shares of the professional, technical, managerial and other staff positions at the new hospital, other medical facilities, office and retail areas; sales and marketing positions supported by the on-going resales and releasing of property at the Project; positions generated at the business and kama'aina-oriented lodge; and myriad other positions generated throughout the economy.[3]

    The net new job estimate is lower than the on-site job estimate because some of the jobs shown at Project facilities could be expected to be created elsewhere on the island even if the Project were not developed.

  - **Personal earnings** - Personal earnings from the new operational positions will increase over time as more facilities and establishments are opened. New personal earnings are projected to total about:

    - $28 million per year from late 2012 to late 2022,
    - $86 million per year from late 2022 to late 2032,
    - $119 million per year from late 2032 to late 2040, and
    - After 2040, some $115 million per year on an ongoing basis.

    The difference between the last, "ongoing" time frame and the 2040 impacts is the expiration of the initial residential and commercial brokerage opportunities.

    On average, these net new FTE positions are expected to earn $47,000 to $50,000 per year during Project buildout, and $50,000 per year after 2040. Considering the 2009-2010

[3] The share of new positions within each employment category reflect judgments about the ability of Project facilities to support activity that might not have otherwise existed, such as offering substantially expanded medical services in the heart of Kona, or attracting kama'aina or business travelers to stay overnight on Hawaii island rather than returning home (taking a business day trip only) or staying with friends.

observed ratio of total family earnings of 1.8 times the average County wage, these earnings could be expected to be associated with average family incomes of about $91,000, or about 132% of the County median reported for fiscal year 2011, on an ongoing basis.

Population Movements

Opportunities created by Kaloko Makai, particularly its professional, technical and managerial career opportunities, will create incentives for some neighbor islanders or former Hawaii residents to move back to the State and/or to the Island of Hawaii.

In addition, some of Kaloko Makai's homes could be expected to attract some households that previously lived off-island or out-of-state. These could include retirees as well as younger households.

- **County** – The influences described above are estimated to result in perhaps 360 persons living on the Island of Hawaii who might not otherwise have lived on the island (in-migration to the County) by late 2022, or up to 1,040 after Project completion in late 2040.

- **State** - Within the above total, some 280 and 780 persons, respectively, are expected to be persons who had previously lived out-of-state.

Fiscal Impacts

- **County** - The Project could be expected to contribute some $10.8 million per year in net additional County revenues at its completion and annually thereafter.
  By late 2040, new County government revenues are estimated to represent about 6.1 times the new County government operating expenditures required to support the additional population that could be attracted to the Island of Hawaii by the Project.

  The Project's real property taxes would be the major contributor to these County net fiscal benefits.

- **State** - For the State, net additional operating revenues generated by the Project are estimated at $5.6 to $8.7 million per year during buildout, when development activity would generate high gross excise and income taxes. The Project is projected to continue to contribute to gains in the State budget in the long-run, with net additional revenues of some $4.1 million per year after 2040.

  These fiscal impacts represent a revenue/expenditure ratio for the State of some 2.9 to 4.6 during buildout, or 2.0 by late 2040 and thereafter.

- **Other** - These public sector contributions do not consider the value of the school sites, public parks or various off-site infrastructural improvements to be contributed by SCD-TSA, including its contributions to the extension of Ane Keohokalole Highway. Neither do they consider the various impacts and permit fees expected to be paid to the County and State governments during the development of the Project.

3. Study Conditions and Terminology

Special considerations and terminology for the analyses on which the preceding results rely are presented in this chapter. For a more complete understanding of the study analyses, one should refer to the exhibits in the next section of this report, and the notes that accompany each exhibit.

Special Considerations

- **Use and classification of residential units** – Although not considered a major market segment, the Project could attract some buyers that previously lived on a neighbor island or out-of-state. These new island residents may be expected to include households at many stages of life, including retirees. This group is distinguished from buyers who are already established island residents in terms of their economic and fiscal impacts.

  - New island residents who buy homes at the Project bring new investments, earnings and expenditures to the State and County. Conversely, they also require additional government resources and services. In short, they generate new economic and fiscal impacts within the County and State.

  - Previously established island residents who buy homes at the Project are assumed to be able to live elsewhere on the Island of Hawaii even if the Project is not developed. Thus, while they may increase population at the Kaloko Makai site itself, from the County and State's standpoint, their presence is not a new impact.

- **Commercial facilities** - The proposed commercial facilities are expected to attract spending from Kaloko Makai and other island residents, as well as Hawaii Island visitors.

  It is likely that Hawaii Island residents and visitors would have spent an equivalent amount on dining out and/or personal services whether or not the Project's commercial facilities were developed. Thus, given a competitive retail and office market on the island, the planned facilities could lead to a geographic reallocation of spending within the region, but would not in themselves be expected to significantly increase expenditures made in the County or State.

  On the other hand, commercial facilities would contribute to the Project's ability to attract residential buyers to Kaloko Makai.

  In other words, Kaloko Makai's on-site commercial facilities will employ workers, pay taxes and generate other economic and fiscal benefits. These are considered directly generated impacts and most of these jobs would be located on-site. However, the net benefits of the Project's commercial facilities are best measured in terms of the new spending that Kaloko Makai attracts to the island, and the taxes and other benefits these persons will generate throughout the County

and State. Many of these impacts are likely to be felt off-site, benefitting establishments throughout the island.

- **Other uses/considerations not modeled** – Kaloko Makai is planned to include one middle and two elementary school sites, with facilities to be built by the State. In addition, Kaloko Makai is proposed to house a new judiciary complex planned by the State. This assessment does not consider the economic and fiscal impacts of the State's planned schools and the potential judiciary center. These facilities are noted but are not evaluated in terms of their economic and fiscal impacts. It is assumed that such facilities would be built somewhere on the island whether or not the Project is developed, and thus Kaloko Makai itself would not generate their impacts.

  Although the developer proposes to contribute land for public facilities, the value of such contributions is not included in this assessment and should be considered additional benefits to State and/or County governments.

- **Entitlement spending not considered** – SCD-TSA's currently on-going entitlement process for Kaloko Makai is already generating significant economic activity and fiscal benefits by employing professionals and supporting various vendors around the state. However, since such benefits are not dependent on the outcome of the entitlement process, they are not enumerated in this analysis.

- **Government expenditures** – State and County revenues and expenses estimated herein are based on the structure of tax collections and services reported for the fiscal years ending June 30, 2010 (FY2010) for the County and June 30, 2009 (FY2009) for the State. The impacts estimated would differ if governmental taxing and spending policies were to be materially altered.

Definition of Key Terms

Within this report, the following definitions apply:

- **Direct impacts** - Those economic, population or other impacts attributable to persons or activities that are a direct result of the proposed development. For instance, direct employment impacts are expected to include those involved in building the proposed facilities, such as construction workers, and those who would later work at them in their operations.

  Many, but not all of direct impacts can be expected to occur on-site. For instance, a portion of the construction budget is for architects and engineers. While such persons' employment might be temporarily dependent on contracts regarding Kaloko Makai, some of these professionals may do the majority of their work from offices in Hilo, Honolulu or elsewhere. Likewise, administrative and managerial staff located off-site would support construction professionals working on-site.

- **Indirect impacts** - Indirect impacts occur when the businesses or persons who are directly affected make expenditures for additional supplies or services. For instance, some of the additional retail spending by those newly attracted to Hawaii by the Project could be spent on

eating out. These elevated dining out expenditures could indirectly increase demand for produce, seafood and meats from Hawaii farms, fishermen and/or ranching enterprises. Kaloko Makai would thus have indirectly supported new business opportunities for area providers of such goods and services.

- **Induced impacts** - Induced impacts occur throughout the community when those persons or companies that have benefited from the direct or indirect impacts of the Project spend their associated earnings on consumer goods and services. For instance, a construction worker may spend her earned wages to buy a new pair of shoes, or to pay for her child's day care. The farmer who sells produce to a restaurant at Kaloko Makai may use some of his profit to take his family out to the movies. The businesses and individuals impacted by such re-spending are said to enjoy induced economic impacts from the Project.

- **Total impacts** - Total impacts are defined as the sum of direct, indirect and induced impacts for any given variable.

- **Resident population** - Resident population refers to all those persons who habitually reside in a given area, whether or not they may have temporarily traveled away.

- **Full-time equivalent** - This study measures employment opportunities in full-time equivalent (FTE) units. One full-time equivalent position is defined herein as 2,080 hours of employment (including paid vacation and sick leave) per year. This is equivalent to 40 hours per week, and may also be referred to as a "person-year" of employment. Two half-time jobs would be considered to together represent one FTE job.

- **Other** – Other special terms used in this analysis are generally defined within the respective exhibit where the term is used.

Report Conditions

Assumptions regarding the scale, nature and timing of the Project are made in order to assess its impacts. This assessment is based on findings of the market study prepared by Mikiko, as well as the assessment of medical-related facilities prepared by Cattaneo & Stroud, as provided to Mikiko by SCD-TSA. This study relies on physical parameters, layouts, timelines, budgets, development programs and other inputs provided by SCD-TSA, Wilson Okamoto Corporation (Wilson Okamoto), and other sources as noted.

In addition, this assessment also incorporates information provided by government agencies, developers, brokers, landowners, and other sources as cited in the exhibits. While attempts have been made to verify such information via multiple sources, it is not always possible to do so.

Mikiko cannot guarantee the accuracy or appropriateness of all information upon which its assessments may be based.

Mikiko has no responsibility to update this report or any of the underlying data for events and circumstances occurring after July 15, 2011, the date of substantial completion of primary data collection.

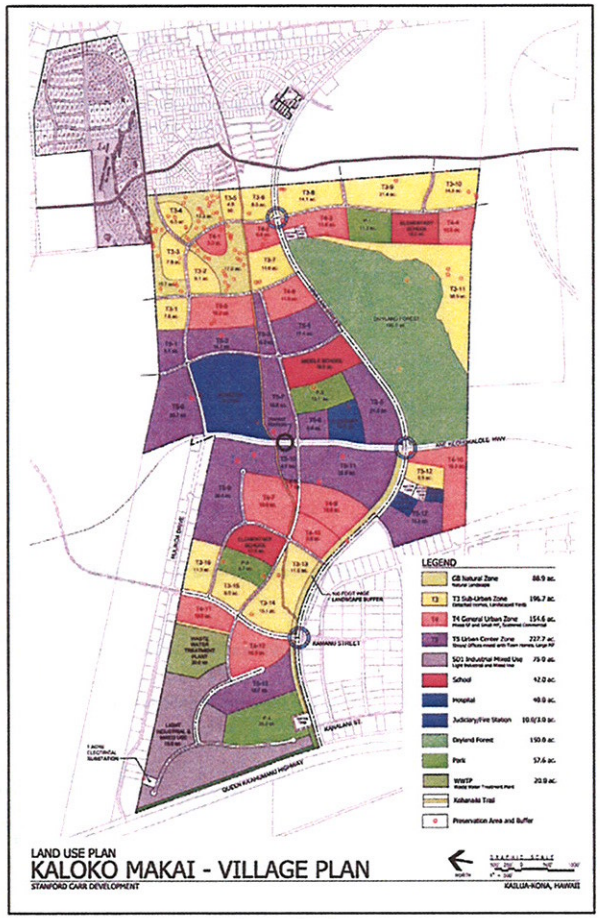
This report is for the planning purposes of SCD-TSA, Wilson Okamoto and their consultants, as well as for public disclosure of the nature of the Project pursuant to seeking State and County land entitlements. It is not intended to be used for solicitation of investment.

This report does not offer an appraisal of the Subject, nor should it be construed as an opinion of value for the Project.

ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR KALOKO MAKAI

Exhibits

Exhibit 1-1
Kaloko Makai – Conceptual Land Use Plan



Source: SCD-TSA Kaloko Makai, 2011.

Exhibit 2-1
Project Concept and Potential Development Timing
2012 to 2040

	Unit	Notes		2012-22	2022-32	2032-40	Total
Highlights of period:		*2012+: infrastructure planning and development* *Parks, schools, open spaces open throughout*		■ *First homes: 2015* ■ *First retail, office & industrial openings* ■ *Out-patient care & SNF/LTC* ■ *Dryland forest*	■ *Lodge & business center* ■ *SNF/ LTC facility expands* ■ *Hospital opens* ■ *Dryland forest*	■ *Full Project buildout* ■ *Hospital & other med facilities expand* ■ *KM fire station opens* ■ *Dryland forest*	192
Development in period:							
Residential unit completions/sales -		*Av. price:*	*Av. sales/year*				
Market units (single & multifamily)	*Sold homes*	*$382,400*	*166*	1,469	1,726	1,105	4,300
Affordable units (multifamily)[1]	*Sold homes*	*$284,500*	*28*	350	220	130	700
Total, residential units/weighted average price	*Rounded*	*$369,000*	*190*	1,819	1,946	1,235	5,000
Light industrial land[2]	*Net acres*	*0.8*	*of gross acres*	20	12	8	40
Light industrial buildings	*Built sq. ft.*	*0.15*	*floor area ratio, with dev. lag*	90,000	90,000	80,000	260,000
Commercial centers	*GLA sq. ft.*	*SCD-TSA development plan*		630,000	370,000	100,000	1,100,000
Lodge and Business Center	*Rooms*			0	120	0	120
Medical facilities:		*Cattaneo & Stroud, June 2011*					
Outpatient care center	*Building GSF*	*Imaging, lab, urgent care, etc.*		24,000	0	6,000	30,000
Hospital	*Building GSF*	*Includes service building*		0	191,000	95,000	286,000
Skilled nursing/long-term care	*Building GSF*			33,000	27,000	23,000	83,000
Schools	*Schools*	*To be developed by State (timing may vary)*		Elementary	Middle	Elementary	3

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Kaloko Makai is planned to include one middle and two elementary schools, and is proposed to house the State's proposed new judiciary center complex. These public facilities are not assessed herein.

1 Affordable unit count based on 5,000 total units generating 1,000 affordable housing credits, and County rules regarding assignment of credits on for-sale units by income range of buyers. See Hawaii County Code, Chapter 11, Section 11-5 (amended 2011.) If additional housing credits are required to address nonresidential units at Kaloko Makai, developer will comply with such requirements.

For illustrative purposes, Hawaii County guidelines in effect as of September 1, 2010 would specify for-sale housing offered to households of two to four persons earning incomes ranging from less than 80% and up to 120% of the County median income be priced from $202,500 to $366,200; figure shown is based on a mix of market orientations that would satisfy the 1,0000 credits expected to be required of the developer.

2 A 25 acre area alongside Queen Kaahumanu Highway is assumed to be taken by the State Department of Transportation for use as a highway interchange between 2022 and 2032.

Sources: SCD-TSA Kaloko Makai, LLC, 2011; Cattaneo & Stroud, 2011; Mikiko Corporation, 2011.

Exhibit 2-1, Continued
Project Concept and Potential Development Timing
2012 to 2040

	Notes	2012-22	2022-32	2032-40
Cumulative development by end of period:				
Residential unit completions/sales -				
Market units (single & multifamily)	*Sold homes*	1,469	3,195	4,300
Affordable units (multifamily)	*Sold homes*	350	570	700
Total		1,819	3,765	5,000
Light industrial land[1]	*Net acres*	20	32	40
Light industrial buildings	*Built sq. ft.*	90,000	180,000	260,000
Commercial centers	*Gross leasable square feet (GLA)*	630,000	1,000,000	1,100,000
Lodge and Business Center	*Rooms*	0	120	120
Medical Facilities:	*Building gross square feet (GSF)*			
Outpatient care center		24,000	24,000	30,000
Hospital		0	191,000	286,000
Skilled nursing/long-term care		33,000	60,000	83,000
Elementary & middle schools	*Number of schools (to be developed by DOE)*	1	2	3

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Kaloko Makai is planned to include one middle and two elementary schools, and is proposed to house the State's proposed new judiciary center complex. These public facilities are not assessed herein.

1 A 25 acre area alongside Queen Kaahumanu Highway is assumed to be taken by the State Department of Transportation for use as a highway interchange between 2022 and 2032.

Sources: SCD-TSA Kaloko Makai, LLC, 2011; Cottaneo & Stroud, 2011; Mikiko Corporation, 2011.

Exhibit 2-2
Buyer Origins and Residential Utilization Patterns
2022, 2032 and 2040

	Basis/reference	2022	2032	2040	After 2040
Usage assumptions:					
Market units-resident housing units (RHU) [1]	*83% of sold market units*	1,213	2,638	3,550	3,550
Market units-non-primary [1]	*17% of sold market units*	256	557	750	750
Affordable units	*100% of sold affordable units*	350	570	700	700
Total	*85% of all units*	1,819	3,765	5,000	5,000
Unit occupancy assumptions:					
Market units-resident housing units (RHU) [1]	*Allowance for vacancy/transitions*	*95%*	*95%*	*95%*	*95%*
Market units-non-primary [1]	*Share of time spent on-island*	*60%*	*60%*	*60%*	*60%*
Affordable units	*Allowance for vacancy/transitions*	*95%*	*95%*	*95%*	*95%*
Utilization pattern:					
Average daily occupied units -	*Exhibit 2-1 + usage assumption*				
Market units-resident housing units (RHU)[1]		1,152	2,506	3,373	3,373
Market units-non-primary[1]		154	334	450	450
Affordable units	*All primary homes*	333	542	665	665
Total, rounded		1,640	3,380	4,490	4,490
Average daily persons in residence -	*Ref market study, Ex. 2-6 (midpoint)*				
Market units-resident housing units (RHU)[1]	*2.8 persons per occupied unit*	3,226	7,017	9,444	9,444
Market units-non-primary[1]	*2.0 persons per occupied unit*	308	669	900	900
Affordable units	*2.9 persons per occupied unit*	964	1,570	1,929	1,929
Total, rounded		4,500	9,260	12,270	12,270

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 Based on projected market mix for the Project and average household sizes for North Kona-North as shown in Market Study, Exhibit 2-6 and Appendix 1.

Exhibit 2-3
Lodge and Business Center Operations and Utilization Patterns
2022, 2032 and 2040

	Basis/reference	2022	2032	2040	After 2040
Number of rooms	*Exhibit 2-1*	0	120	120	120
Unit occupancy assumptions:					
Average occupancy		0%	60%	65%	65%
Average party size	*Number of persons per occupied room*	0.0	1.8	1.8	1.8
Average daily guests	*Rounded*	0	130	140	140
Projected guest mix:					
Island residents -		0%	5%	5%	5%
Neighbor island residents -					
Business		0%	30%	30%	30%
Visiting friends & family		0%	15%	15%	15%
Sports or other event/group travel		0%	10%	10%	10%
Subtotal		0%	55%	55%	55%
Out-of-state residents -					
Business		0%	20%	20%	20%
Visiting friends & family		0%	15%	15%	15%
Sports or other event/group travel		0%	5%	5%	5%
Subtotal		0%	40%	40%	40%
Total		0%	100%	100%	100%
Average daily room rate	*Mid-point of projected low and high ranges in Market Study*	$0	$120	$130	$130
Projected revenues	*In millions*				
Rooms		$0.0	$3.2	$3.7	$3.7
Other (sundries, parking, business services, etc.)	*$10.00 per occupied room*	$0.0	$0.3	$0.3	$0.3
		$0.0	$3.4	$4.0	$4.0

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

Sources: SCD-TSA Kaloko Makai, LLC, 2011; Mikiko Corporation, Market Study, 2011.

Exhibit 3-1
Visitor and Non-Primary Resident Expenditures in Hawaii, Average Annual
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions)		2022	2032	2040	After 2040
Non-primary residents:						
Bases for projection:						
Average household income[1]	*Approximate 90th percentile, 2010 North Kona-North resident incomes*	$200,000				
Percent of income spent on island[2]	*50% times % of year on-island (Ex. 2-2), =*	30%				
Persons per household	*Exhibit 2-2*	2.0				
Projections:						
Direct expenditures	*Expenditure per FTE person:*	$30,000	$9.2	$20.1	$27.0	$27.0
Indirect & induced	*1.00 multiplier*[3]		$9.2	$20.0	$26.9	$26.9
Total			$18.4	$40.0	$53.9	$53.9
Visitors to Hawaii Island:						
From neighbor islands:						
Number of visitors	*Based on share of visitors shown in Exhibit 2-3*		-	72	77	77
Direct expenditures	*Based on share of revenues shown in Exhibit 2-3*		$0.0	$1.9	$2.2	$2.2
Indirect & induced	*1.00 multiplier*[3]		$0.0	$1.9	$2.2	$2.2
Total			$0.0	$3.8	$4.4	$4.4
From out-of-State:						
Number of visitors	*Based on share of visitors shown in Exhibit 2-3*		-	52	56	56
Direct expenditures	*Based on share of revenues shown in Exhibit 2-3*		$0.0	$1.4	$1.6	$1.6
Indirect & induced	*1.00 multiplier*[3]		$0.0	$1.4	$1.6	$1.6
Total			$0.0	$2.7	$3.2	$3.2

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 See market study, Exhibit 2-7.

2 Corroborates with benchmark estimate of average spending on local consumption items of 53% of pre-tax income, considering that recent in-migrants may have more on-going obligations or interests outside of the state than do previously established residents. Estimates derived from figures shown in Department of Business, Economic Development and Tourism, State of Hawaii Data Book 2006, "Table 13.25. Average Annual Expenditures and Other Characteristics of Consumer Units, for Honolulu, 2000-2001 to 2004-2005," 2004-2005 figures, excluding shelter and personal insurance and pensions expenditures. DBEDT source references U.S. Bureau of Labor Statistics, Selected Western Metropolitan Statistical Areas: Average annual Expenditures and Characteristics, Consumer Expenditure Survey (annual.)

3 Based on Type II Direct-Effect Multipliers for earnings (less 1.0 each) as shown by industry groups in Appendix 1. Non-primary residents based on all industries shown.

Exhibit 3-2
Industry Coefficients and Multipliers for Development Activities

FINAL DEMAND INDUSTRY COEFFICIENTS[1]

	DBEDT industrial categories applied	Final demand coefficient per $1 million (2002$) project cost: Jobs[2]	FTE factor[3]	$ Earnings[4]
Professional services	*#45-Architectural and engineering services*	10.31	0.81	0.63
Construction:				
Residential units	*#13-SF housing construction, #14-Construction of other buildings*	7.99	0.90	0.40
Light industrial	*#14-Construction of other buildings*	8.41	0.90	0.44
Commercial facilities	*#14-Construction of other buildings*	8.41	0.90	0.44
Tenant improvements	*#14-Construction of other buildings*	8.41	0.90	0.44
Lodge and Business Center	*#14-Construction of other buildings*	8.41	0.90	0.44
Medical facilities	*#14-Construction of other buildings*	8.41	0.90	0.44
Wastewater treatment plan	*#14-Construction of other buildings*	8.41	0.90	0.44
Infrastructure	*#15-Heavy & civil engineering construction*	11.61	0.90	0.86
Other costs	*#42-Real estate, #44-Legal services, #40-Other finance and insurance*	8.55	0.81	0.52

DIRECT-EFFECT INDUSTRY MULTIPLIERS[5]

	DBEDT industrial categories applied	Indirect & induced multiplier per direct: FTE job	$ Earnings[4]
Professional services	*Same as above*	1.03	0.63
Construction:			
Residential units	*Same as above*	1.46	1.12
Light industrial	*Same as above*	1.42	1.05
Commercial facilities	*Same as above*	1.42	1.05
Tenant improvements	*Same as above*	1.42	1.05
Lodge and Business Center	*Same as above*	1.42	1.05
Medical facilities	*Same as above*	1.42	1.05
Wastewater treatment plan		1.42	1.05
Infrastructure	*Same as above*	1.40	0.67
Other	*Same as above*	0.97	1.17

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 For direct impacts of development expenditures. Type I total jobs and earnings direct impact coefficients, from Hawaii State Department of Business, Economic Development & Tourism, "The 2002 State Input-Output Study for Hawaii," June 2006 (revised from May 2006), Detailed Tables. Jobs coefficients are for 2012; earnings coefficients not provided for future years.

2 Input-Output Study estimates total wage, salaried and proprietary jobs, both full- and part-time (not full-time equivalent).

3 Adjustment factor applied in addition to the jobs coefficient to estimate full-time equivalent jobs at 40 hours per week. Factor derived from statewide annual data for 2007 to 2010 on average weekly hours reported worked in the private sector professional and business services, and the mining and construction industries, as reported by State of Hawaii, Department of Labor & Industrial Relations, at http://www.hiwi.org/gsipub/index.asp?docid=419, as accessed July 10, 2011.

4 Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

5 For indirect and induced impacts of respective direct impacts. Indirect and induced factors derived from Type II Direct-Effect total job/total job and earnings/earnings multipliers as shown in DBEDT, Ibid, "Job multipliers for 2012-2012" and "2002 Detailed Output, Earnings and Tax Multipliers for Hawaii."

Exhibit 3-3
Estimated Current Development Costs: Total for Each Period
2012 to 2040 (2011 and 2002 dollars, in millions unless stated)

	Basis/reference (not in mils unless stated)	2012 2022	2022 2032	2032 2040	Total
In 2011 dollars:[1]					
Professional services[2]	*Design, planning, engineering, legal, etc.*	$45.13	$45.94	$24.09	$115.2
Construction -	*Net of contingencies & residential options*				
Residential units		$236.7	$321.02	$244.9	$802.7
Light industrial	*$75 PSF in place as of date*	$6.8	$6.8	$6.0	$19.5
Commercial facilities	*$240 PSF in place as of date*	$151.2	$88.8	$24.0	$264.0
Tenant improvements[3]	*$170 Per square foot industrial & commercial space*	$122.4	$78.2	$30.6	$231.2
Lodge and Business Center		$0.0	$67.2	$0.0	$67.2
Medical facilities	Urgent care, SNF/LTC, hospital	$8.0	$94.3	$50.3	$152.6
Waste water treatment plant	Building aspects of WWTP only	$3.9	$1.7	$1.7	$7.2
Horizontal (infrastructure)[4]	*Site preparation, utilities, roads*	$177.8	$184.0	$122.6	$484.4
Subtotal		$706.7	$841.9	$480.0	$2,028.6
Other	*Soft costs such as home office overhead*	$9.0	$9.8	$6.7	$25.5
Total, rounded		$769.8	$897.7	$510.8	$2,169.3
In 2002 dollars:[5]	*68% of 2011 values*				
Professional services		$30.8	$31.4	$16.5	$78.7
Construction -					
Residential units		$161.8	$219.4	$167.4	$548.5
Light industrial		$4.6	$4.6	$4.1	$13.3
Commercial facilities		$103.3	$60.7	$16.4	$180.4
Tenant improvements		$83.6	$53.4	$20.9	$158.0
Lodge and Business Center		$0.0	$45.9	$0.0	$45.9
Medical facilities		$5.4	$64.5	$34.3	$104.2
Waste water treatment plant		$2.6	$1.1	$1.1	$4.9
Infrastructure		$121.5	$125.7	$83.8	$331.0
Other		$6.1	$6.7	$4.6	$17.4
Total, rounded		$519.9	$613.4	$349.1	$1,482.4

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 Provided by SCD-TSA Kaloko Makai, LLC, 2011, unless otherwise noted.

2 Excludes consultant services related to entitlement efforts.

3 Includes developer- and tenant-provided construction budgets. Comparison examples for first generation buildouts include office space at $150-170 per square foot, and retail at $150-$250 per square foot, as provided by Colliers Monroe Friedlander, 2007; restaurants minimum $300 per square foot per SL Sofos & Co., Ltd.; industrial at $50 PSF. Weighted average figure inflated to 2011 dollars.

4 Covers development pads with utility installation; private and public parks and trails; subdivision and collector roads; developer's estimated contribution to extension of Ane Keohokalole Highway

5 Based on Honolulu single-family home and high-rise building construction cost indices (averaged) for 2002-2010 as reported by UHERO, Data Portal, as accessed July 7, 2011. 2010 to 2011 inflation assumed to be nominal (UHERO estimated the 2009-2010 construction cost index change at 0.3%.)

Exhibit 3-4
Estimated Current Development Costs: Average Annual
2012 to 2040 (2011 dollars, in millions)

	Basis/reference	2012 2022	2022 2032	2032 2040	Overall average
Costs by type:	*Exhibit 3-3, annualized*				
Professional services		$4.5	$4.6	$3.0	$4.1
Construction -					
Residential units		$23.7	$32.1	$30.6	$28.7
Light industrial		$0.7	$0.7	$0.8	$0.7
Commercial facilities		$15.1	$8.9	$3.0	$9.4
Tenant improvements[1]		$12.2	$7.8	$3.8	$8.3
Lodge and Business Center		$0.0	$6.7	$0.0	$2.4
Medical facilities		$0.8	$9.4	$6.3	$5.4
Waste water treatment plant		$0.4	$0.2	$0.2	$0.3
Infrastructure[2]		$17.8	$18.4	$15.3	$17.3
Other		$0.9	$1.0	$0.8	$0.9
Total, rounded		**$76.1**	**$89.8**	**$63.9**	**$77.5**

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 Includes developer- and tenant-provided construction budgets.

2 Covers development pads with utility installation; private and public parks and trails; subdivision and collector roads; developer's estimated contribution to extension of Ane Keohokalole Highway.

Exhibit 3-5
Development Employment, FTE Jobs[1]
2012 to 2040 (Total in each period)

	Basis/reference	2012 2022	2022 2032	2032 2040	Total/ average
Total:					
Direct jobs -	*Exhibits 3-2 and 3-3*				
Professional services		258	262	137	657
Construction -					
Residential units		1,163	1,578	1,204	3,944
Light industrial		35	35	31	101
Commercial facilities		782	459	124	1,365
Tenant improvements[2]		633	404	158	1,196
Lodge and Business Center		0	348	0	348
Medical facilities		41	488	260	789
Wastewater treatment plan		20	9	9	37
Infrastructure[3]		1,270	1,313	876	3,459
Other		43	46	32	121
Subtotal direct jobs (rounded)		4,200	4,900	2,800	12,000
Indirect and induced jobs[4]	*Exhibit 3-2*	5,928	6,932	3,982	16,842
Total jobs (rounded)		**10,100**	**11,800**	**6,800**	**28,800**
Average annual:					
Direct jobs -					
Professional services		26	26	17	23
Construction[2,3]		394	463	333	401
Other		4	5	4	4
Subtotal direct jobs (rounded)		420	490	350	430
Indirect and induced jobs[4]		593	693	498	601
Total jobs (rounded)		**1,000**	**1,200**	**800**	**1,000**

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 FTE = Full time equivalent, defined as 40 hours per week or 2,080 hours per year.

2 Includes employees supported by developer- and tenant-provided construction activities.

3 Covers development pads with utility installation; private and public parks and trails; subdivision and collector roads; developer's estimated contribution to extension of Ane Keohokalole Highway.

4 Based on weighted average of Direct-Effect jobs multipliers for each job category, as shown on Exhibit 3-2.

Exhibit 3-6
Personal Earnings from Development - Total in Period
2012 to 2040 (2011 dollars, in millions)

	Basis/reference	2012 2022	2022 2032	2032 2040	Total
	Exhibits 3-2 & 3-3				
Direct earnings[1]:					
Professional services		$19.5	$19.9	$10.4	$49.8
Construction -					
Residential units		$72.2	$97.9	$74.7	$244.9
Light industrial		$2.3	$2.3	$2.0	$6.5
Commercial facilities		$50.7	$29.8	$8.1	$88.6
Tenant improvements[2]		$41.1	$26.2	$10.3	$77.6
Lodge and Business Center		$0.0	$22.5	$0.0	$22.5
Medical facilities		$2.7	$31.7	$16.9	$51.2
Wastewater treatment plan		$1.3	$0.6	$0.6	$2.4
Infrastructure[3]		$116.6	$120.6	$80.4	$317.7
Other		$3.2	$3.5	$2.4	$9.1
Subtotal, direct		**$309.6**	**$355.0**	**$205.7**	**$870.3**
Indirect and induced earnings[4]		$278.0	$325.8	$186.6	$790.4
Total earnings		**$587.6**	**$680.8**	**$392.3**	**$1,660.7**

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

1 Based on industry coefficients and FTE factors as shown in Exhibit 3-2 and estimated construction costs in 2002 dollars, as shown in Exhibit 3-3. Figures inflated 24.0% to estimated 2011 wages based on average annual hourly wage data for statewide mining and construction industry from 2002 to 2010, as provided by State of Hawaii, Department of Labor & Industrial Relations, HIWI (Hawaii Workforce Infonet) at http://www.hiwi.org/analyzer/ as accessed July 10, 2011.

2 Includes earnings supported by developer- and tenant-provided construction activities

3 Covers development pads with utility installation; private and public parks and trails; subdivision and collector roads; developer's estimated contribution to extension of Ane Keohokalole Highway

4 Weighted average of estimated direct earnings by industry as shown above, and Direct-Effect industry multipliers shown in Exhibit 3-2

Exhibit 3-7
Personal Earnings from Development - Average Annual
2012 to 2040 (2011 dollars, in millions except average earnings)

	Basis/reference	2012 2022	2022 2032	2032 2040	Average
Average annual in period (rounded):	*Exhibit 3-6, refers to all jobs*				
Direct earnings		$31	$36	$26	$31
Indirect & induced earnings		$28	$33	$23	$28
Total earnings		$59	$68	$49	$59
Average per new FTE job:	*Exhibits 3-5 and 3-6, rounded*				
Direct jobs		$74,000	$72,000	$73,000	$73,000
Indirect and induced jobs		$47,000	$47,000	$47,000	$47,000
Average per job		$58,000	$58,000	$58,000	$58,000
Estimated average family income[1]	*1.8 times average wage*				
For direct job-holders		$135,000	$131,000	$133,000	$133,000
For indirect and induced job-holders		$86,000	$86,000	$86,000	$86,000
All Project-related job-holders		$106,000	$106,000	$106,000	$106,000
Percent of median income[2]:	*$68,700 median family income, FY2011, Hawaii County*				
For direct job-holders		197%	191%	194%	194%
For indirect and induced job-holders		125%	125%	125%	125%
All Project-related job-holders		154%	154%	154%	154%

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance.

1 Ratio estimated from 2009 average annual wage in Hawaii County, all occupations, as provided by State of Hawaii, Department of Labor & Industrial Relations, and FY 2010 median family income in the County, as provided by U.S. Department of Housing & Urban Development, HUD USER. Reflects multiple job-holders within each family as well as multiple job-holding by individuals.

2 U.S. Department of Housing & Urban Development, HUD USER, as accessed July 10, 2011

Exhibit 3-8
Direct On-Site Operational Employment, FTE Jobs
2022, 2032 and 2040

	Basis/reference	2022	2032	2040	After 2040
Commercial facilities -					
Light industrial	*600 square feet per FTE job*	150	300	433	433
Commercial retail/office	*425 square feet general commercial area per FTE job*	1,482	2,353	2,588	2,588
Other facilities -					
Lodge and Business Center	*0.3 FTE jobs per room*	0	36	36	36
Medical facilities	*Cattaneo & Stroud, Inc., 2011*				
Outpatient care center		47	47	59	59
Hospital		0	550	825	825
Skilled nursing/long-term care		80	160	240	240
Total on-site jobs, rounded		1,800	3,400	4,200	4,200

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.
Excludes impacts of planned schools and proposed Judiciary Center. Also does not capture Realtors and brokers that may locate on-site, private household maintenance and other assistance, potential employees of community association(s) or employees of the waste water treatment plant.

Exhibit 3-9
Net Additional Operational Employment, FTE Jobs[1]
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference	2022	2032	2040	After 2040
Bases for projection:					
Av. annual spending by non-primary residents	*Direct, indirect & induced (new to island): Exhibit 3-1*	*$18.4*	*$40.0*	*$53.9*	*$53.9*
Av. annual residential selling costs	*See Exhibit 3-1*				
Sell-out of developer inventory	*2.0% of gross sales, preceding years*[2]	*$1.7*	*$1.4*	*$1.1*	*$0.0*
Resales	*3.0% Turnover per year*[3] *6.0% of gross sales, same av. price*	*$0.2*	*$0.3*	*$0.4*	*$0.4*
Projected net additional jobs:					
Direct -					
Attributable to non-primary residents[4]	*22.8 /$mil, net margin, 35%*	147	319	430	430
Real estate leasing & sales	*14.0 /$mil selling costs, new and resales*	26	24	22	6
Light industrial	*10% assumed net new jobs, see Ex. 3-8*	15	30	43	43
Lodge and Business Center	*25% assumed net new jobs, see Ex. 3-8*	0	9	9	9
Medical facilities	*60% assumed net new jobs, see Ex. 3-8*	76	454	674	674
Subtotal, direct jobs, rounded		260	840	1,180	1,160
Indirect and induced -	*Multiplier and industry category applied*[5]				
Attributable to non-primary residents[4]	*1.08 Average of select industries*	158	344	463	463
Real estate leasing & sales	*1.91 Real estate & rentals industries*	49	45	42	11
Light industrial	*0.91 Average of select industries*	14	27	40	40
Lodge and Business Center	*1.06 Accommodations industry*	0	10	10	10
Medical facilities	*0.91 Health services industry*	69	413	614	614
Subtotal, indirect & induced jobs, rounded		290	840	1,170	1,140
Total net additional jobs , rounded		600	1,700	2,400	2,300

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 FTE = Full time equivalent, defined as 40 hours per week or 2,080 hours per year.

2 Represents 2% inside commissions; no outside commissions.

3 Resales activity assumed 3.0% of completed and sold residential inventory shown in Exhibit 2-1. Resales factor considers 2010 Hawaii Island recorded sales of 2,022 resales vs. 69,100 housing units (2.9%): see Mikiko Market Study, Exhibits 2-6 and 3-2. Commissions and other selling costs estimated at rate shown and average prices shown in Exhibit 2-1.

4 Category addresses commercial impact, including shopping center and office operational employment, since net additional employment is largely considered a function of induced new spending on-island, not leasable area to be developed in the Project. Also spending by existing island residents, such as at the commercial centers to be developed, is assumed to have occurred elsewhere on-island even if the Project were not developed.
Retail spending subject to reduction by 35% assumed retail trade margin prior to application of weighted average Type II jobs multiplier shown in Appendix 1.
This results in conservative estimates since DBEDT multipliers for many applicable industry categories such as services, agriculture, food processing & etc. are calculated assuming they will be applied to total expenditures rather than trade margin expenditures.

5 Based on Type II Direct-Effect Multipliers for employment (less 1.0 each) as shown by industry groups in Appendix 1. non-primary residents based on all industries shown.

Exhibit 3-10
Personal Earnings from Net New Operational Activity - Total Annual
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions)	2022	2032	2040	After 2040
Direct earnings -	*Estimated average FTE salary or other basis* [1]:				
Attributable to non-primary residents[2]	*$37,900 Estimated average Hawaii County wage, 2011*	$5.6	$12.1	$16.2	$16.2
Real estate sales & marketing -	*Residential & commercial properties, Ex. 3-9*				
Sell out of developed inventory		$1.7	$1.4	$1.1	$0.0
On-going resales after 2012		$0.2	$0.3	$0.4	$0.4
Light industrial	*$48,300 average wage, select industries*	$0.7	$1.4	$2.1	$2.1
Lodge and Business Center	*$37,200 average wage, accommodation and*	$0.0	$0.3	$0.3	$0.3
Medical facilities	*$66,200 Cattaneo & Stroud* [1]	$5.0	$30.1	$44.6	$44.6
Subtotal, direct earnings		$13.1	$45.6	$64.9	$63.7
Indirect and induced earnings -	*Multiplier and industry category* [3]:				
Attributable to non-primary reside:	*1.00 Average of select industries*	$5.5	$12.0	$16.2	$16.2
Real estate leasing and sales	*3.07 Real estate & rentals industries*	$5.6	$5.2	$4.8	$1.3
Light industrial	*0.75 Average of select industries*	$0.5	$1.1	$1.6	$1.6
Lodge and Business Center	*0.90 Accommodations industry*	$0.0	$0.3	$0.3	$0.3
Medical facilities	*0.71 Health services industry*	$3.6	$21.3	$31.7	$31.7
Subtotal, indirect & induced		$15.3	$39.9	$54.5	$51.0
Total earnings, rounded		$28.4	$85.5	$119.4	$114.8

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance. They would not include tips. The figures shown are considered conservative in that only wage data is available for the "non-primary resident," light industrial and hotel employment categories

Exhibit portrays only those earnings from positions that would be new to the community, not on all employment associated with Project.

1 Average Honolulu salary based on $36,556 reported for 2009 by Department of Labor and Industrial Relations, "Quarterly Census of Employment and Wages" as accessed July 10, 2011; inflation to 2011 dollars based on Honolulu CPI-U for second half 2010 vs. first half 2009. Considered conservative because it incorporates no adjustment to FTE work

2 Includes employment at all commercial facilities statewide, as supported by new resident spending.

3 Based on Type II Direct-Effect Multipliers for earnings (less 1.0 each) as shown by industry groups in Appendix 1. non-primary residents based on all industries shown.

Exhibit 3-11
Personal Earnings from Net New Operational Activity - Average Per Job and Per Family
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference	2022	2032	2040	After 2040
Average earnings per new FTE job:	*Not in millions*				
Direct jobs		$51,000	$54,000	$55,000	$55,000
Indirect and induced jobs		$53,000	$48,000	$47,000	$45,000
Average per job		$47,000	$50,000	$50,000	$50,000
Estimated average family income[1]:	*1.6 times average wage: not in millions*				
For direct job-holders		$93,000	$99,000	$100,000	$100,000
For indirect and induced job-holders		$97,000	$83,000	$86,000	$82,000
All Project-related job-holders		$86,000	$91,000	$91,000	$91,000
Percent of median income[2]:	*$68,700 median family income, FY2011, Hawaii County*				
For direct job-holders		135%	144%	146%	146%
For indirect and induced job-holders		141%	128%	125%	119%
All Project-related job-holders		125%	132%	132%	132%

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Exhibit portrays only those earnings from positions that would be new to the community, not on all employment associated with the Project

Earnings defined to include wage, salary and proprietary incomes, plus directors' fees and employer contributions to health insurance, less employee contributions to social insurance

1 Ratio estimated from 2009 average annual wage in Hawaii County, all occupations, as provided by State of Hawaii, Department of Labor & Industrial Relations, and FY 2010 median family income in the County, as provided by U.S. Department of Housing & Urban Development, HUD USER. Reflects multiple job-holders within each family as well as multiple job-holding by individuals

2 Median family income from U.S. Department of Housing & Urban Development, HUD USER, as accessed July 10, 2011.

Exhibit 4-1
Average Daily In-Migrant Population
2022, 2032 and 2040

	Basis/reference	2022	2032	2040	After 2040
Non-primary residents at Project:					
Average FTE persons in residence	*At non-primary resident units: Exhibit 2-2*	308	669	900	900
In-migrants to State (rounded)	*80% of FTE persons in residence*	250	530	720	720
In-migrants to Co. (rounded)[1]	*100% of FTE persons in residence*	310	670	900	900
Employees:					
In-migrants to the State[1] -	*Subset of in-migrants to County*				
Development employees	*2% of direct av. annual jobs (Ex. 3-5)*	8	10	7	0
Direct operational employees	*3% of net jobs generated (Exhibit 3-9)*	8	25	35	35
Dependents[2]	*Ratio of in-migrant employees*	10	30	40	30
In-migrants to State (rounded)[3]		30	70	80	60
In-migrants to County[3] -	*Includes in-migrants to State*				
Development employees	*4% of direct av. annual jobs (Ex. 3-5)*	17	20	14	0
Operational employees	*6% of net jobs generated (Exhibit 3-9)*	16	50	71	70
Dependents[2]	*Ratio of in-migrant employees*	20	50	70	70
In-migrants to County (rounded)[3]		50	120	150	140
Total in-migrants:	*Those attracted by new residences plus those attracted by net new employment*				
To State		280	600	800	780
To County		360	790	1,050	1,040

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 Subset of County in-migrants. See footnote 3, below.

2 In-migrant dependents estimated to average 0.2 per in-migrant development employee, and 1.0 per in-migrant operational employee.

3 In-migrants to the County include all those moving to the State plus any that may move between islands due to job opportunities at the Project.

Exhibit 5-1
Real Property Taxes Generated by Development
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions unless specified)	2022	2032	2040	After 2040
Total assessed values:					
Improved residential: Primary homes	*$366,000 Average home value, market and affordable home mix (Ex. 2-2)*	$572.0	$1,174.1	$1,555.6	$1,555.6
Unimproved residential: RHUs[1]	*$16,900,000 estimated total value in T3,4&5 residential areas, of which RHUs = 85%*	$9.1	$3.5	$0.0	$0.0
Improved residential: Other	*$382,400 Average home value, market homes only (Ex. 2-2)*	$98.0	$213.1	$286.8	$286.8
Unimproved residential: Non-primary homes[2]	*$16,900,000 estimated total value in T3,4&5 residential areas, of which non-RHUs= 15%*	$1.67	$0.65	$0.0	$0.0
Light industrial - land[3]	*60 max. net acres, at: $750,000*	$45.0	$45.0	$29.7	$29.7
Light industrial - improvements	*Vert. cost + indust. share of TI @ 19%*	$30.2	$51.9	$63.7	$63.7
Commercial - land[4]	*96 acres, @ per acre: $475,000*	$45.7	$45.7	$45.7	$45.7
Commercial - improvements	*Vert. cost + comm. share of TI @ 81%*	$250.2	$402.3	$451.0	$451.0
Lodge and Business Center - land[4]	*5 acres, @ per acre: $475,000*	$2.4	$2.4	$2.4	$2.4
Lodge and Business Center - improvements	*Vertical cost (Ex. 3-3)*	$0.0	$67.2	$67.2	$67.2
Hospital, outpatient & SNF/LTC facilities	*Assumed exempt*	$0.0	$0.0	$0.0	$0.0
Judiciary center and schools	*Assumed exempt*	$0.0	$0.0	$0.0	$0.0
Parks, recreation center & other[5]	*Not estimated*	$0.0	$0.0	$0.0	$0.0
Total assessed values		$473.1	$828.2	$946.5	$946.5

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.
TI - Tenant improvements; RPT - real property tax.

1 T3, 4 & 5 mixed-use areas comprise some 593 acres, of which some 0% or 0 are allocated to residential uses for taxation purposes, based on their respective floor areas in the master plan. Such lands are assumed to be valued for tax purposes at $35,000 per acre, based on the value of unimproved residential zoned lands at Kaloko Heights. This results in a total Kaloko Makai residential land valuation of $0.0 million, which is allocated pro-rata based on remaining number of residential units to be developed in any given time period.

2 Balance of the T3, 4 & 5 mixed-use areas not allocated to residential uses (except site proposed for lodge use).

3 75 gross acres (60 net) proposed for initial zoning, of which 25 gross are assumed to be taken for public use in the 2031-2040 time frame. Net acre valuation based on 2011 tax assessed values for land at 13 properties sampled in Kaloko Industrial Park and Kohanaiki Industrial Park (Hawaii Information Service records.)

4 Tax assessed value based on unimproved commercial zoned lands at Kaloko Heights as of 2010 (FY2011 TAV assumed to be unchanged.)

5 Taxes on parks, recreation center, schools and open spaces not estimated as they are assumed to be exempt (if publicly owned) and/or taxed at a minimal level.

5 Estimated at $40,000 based on Hawaii County policy of a base home exemption of $40,000 plus 20% of average home value, estimated $0 as shown above; exemption applied only to the 0 units believed to be used as primary residences, as shown in Exhibit 2-2. Homeowners aged 70 and older may qualify for a higher exemption amount of up to $180,000 (not factored in here.)

Exhibit 5-1, Continued
Real Property Taxes Generated by Development
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions unless specified)		2022	2032	2040	After 2040
Real property tax revenues:						
Potential new revenues -	*FY 2012 rates per $1,000 net taxable value*					
Improved residential: Primary homes	*$5.55*	*Affordable rental & homeowner housing*	$3.2	$6.5	$8.6	$8.6
Unimproved residential: Primary homes	*$5.55*	*Affordable rental & homeowner housing*	$0.1	$0.0	$0.0	$0.0
Improved residential: Other	*$9.10*	*Improved Residential*	$0.9	$1.9	$2.6	$2.6
Unimproved residential: Other	*$9.10*	*Unimproved Residential*	$0.0	$0.0	$0.0	$0.0
Light industrial - land	*$9.10*	*Industrial*	$0.4	$0.4	$0.3	$0.3
Light industrial - improvements	*$9.10*	*Industrial*	$0.3	$0.5	$0.6	$0.6
Commercial - land	*$9.10*	*Commercial*	$0.4	$0.4	$0.4	$0.4
Commercial - improvements	*$9.10*	*Commercial*	$2.3	$3.7	$4.1	$4.1
Lodge and Business Center - land	*$9.85*	*Hotel*	$0.0	$0.0	$0.0	$0.0
Lodge and Business Center - improvements	*$9.85*	*Hotel*	$0.0	$0.7	$0.7	$0.7
Hospital, outpatient & SNF/LTC	*$0.00*	*Assumed exempt*	$0.0	$0.0	$0.0	$0.0
Judiciary center and schools	*$0.00*	*Assumed exempt*	$0.0	$0.0	$0.0	$0.0
Parks, forest & natural spaces[4]	*$0.00*	*Not estimated*	$0.0	$0.0	$0.0	$0.0
Subtotal, potential tax revenues			$7.5	$14.1	$17.3	$17.3
Less deductions -						
RPT payments prior to Project	*$260,000*	*FY 2011, per SCD-TSA*	$0.3	$0.3	$0.3	$0.3
Homeowners' exemption[5]	*$113,200*	*/unit, primary residences (Ex. 2-2)*	$1.6	$3.3	$4.4	$4.4
Subtotal deductions			$1.9	$3.6	$4.6	$4.6
Estimated net additional RPT			**$5.7**	**$10.6**	**$12.7**	**$12.7**

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.
TI - Tenant improvements; RPT - real property tax.

1 T3, 4 & 5 mixed-use areas comprise some 578 acres, of which some 83% or 482 are allocated to residential uses for taxation purposes, based on their respective floor areas in the master plan. Such lands are assumed to be valued for tax purposes at $35,000 per acre, based on the value of unimproved residential zoned lands at Kaloko Heights. This results in a total Kaloko Makai residential land valuation of $16.9 million, which is allocated pro-rata based on remaining number of residential units to be developed in any given time period.

2 Balance of the T3, 4 & 5 mixed-use areas not allocated to residential uses (except site proposed for lodge use).

3 75 gross acres (60 net) proposed for initial zoning, of which 25 gross are assumed to be taken for public use in the 2031-2040 time frame. Net acre valuation based on 2011 tax assessed values for land at 13 properties sampled in Kaloko Industrial Park and Kohanaiki Industrial Park (Hawaii Information Service records.)

4 Tax assessed value based on unimproved commercial zoned lands at Kaloko Heights as of 2010 (FY2011 TAV assumed to be unchanged.)

5 Taxes on parks, recreation center, schools and open spaces not estimated as they are assumed to be exempt (if publicly owned) and/or taxed at a minimal level

6 Estimated at $113,200 based on Hawaii County policy of a basic home exemption of $40,000 plus 20% of average home value, estimated $73,200 as shown above; exemption applied only to the 4,250 units believed to be used as primary residences, as shown in Exhibit 2-2. Homeowners aged 70 and older may qualify for a higher exemption amount of up to $180,000 (not factored in here.)

Exhibit 5-2
Total Annual Revenues to County Government
Attributable to Development & In-Migrant Population
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions)	2022	2032	2040	After 2040
Bases for projection:					
FTE in-migrants to County -	*Exhibit 4-1*				
Project non-primary residents		*310*	*670*	*900*	*900*
Employees and their dependents		*50*	*120*	*150*	*140*
Estimated tax and other revenues:					
Net new property tax revenues	*Exhibit 5-1*	$5.7	$10.6	$12.7	$12.7
Taxes and other revenue sources from in-migrant residents[1]	*Other than real property taxes* *$225 per person (residents + employees)*	$0.1	$0.2	$0.2	$0.2
Transient accommodations tax[2]	*8.3% of total TAT collections (see 5-2 and 5-3)*	$0.0	$0.0	$0.0	$0.0
Total new County revenues		**$5.7**	**$10.8**	**$12.9**	**$12.9**

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 Includes fuel taxes, licenses and permits and charges for services. Excludes public utility franchise taxes, public service company taxes, investment & other miscellaneous revenues. As stated in County of Hawaii, "Comprehensive Annual Financial Report Fiscal Year Ended June 30, 2010," December 2010. Based on governmental funds statement of revenues, expenditures ad changes in fund balances, pg. 32.

2 Based on Hawaii County share of 18.6% of the 44.8% of the TAT revenues that are distributed among the four counties, per State tax policy. Note 2011 Legislature passed a cap on amount of State TAT collections that may be passed to Counties, which amount may have already been exceeded; however subject property would generate negligible additional TAT for Hawaii County in any case.

Exhibit 5-3
Bases for Projecting State Government Revenues
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference	2022	2032	2040	After 2040
For GET calculations:					
Project development costs -	*Exhibit 3-4, average annual for preceding period*				
Professional services		$4.5	$4.6	$3.0	$0.0
Construction and other		$71.6	$85.2	$60.8	$0.0
Subtotal development cost		$76.1	$89.8	$63.9	$0.0
Real estate sales & marketing	*Based on average activity in prior 5 years*				
Residential	*New and resold units, Exhibit 3-9*	$1.8	$1.7	$1.6	$0.4
Spending by non-primary residents	*In-State spending: Exhibit 3-9*	$18.4	$40.0	$53.9	$53.9
Spending by in-migrant employees to the State & their dependents -					
Number of persons	*Exhibit 4-1, employment impact only*	30	70	80	60
Estimated number households	*2.3 persons per household (compare Ex. 2-2)*	13	30	35	26
In-State spending by hhds[1]	*58% of average of earnings per development and operational job (see notes below)*	$0.4	$1.0	$1.1	$0.4
Lodge and Business Center, all revenues	*Exhibit 2-3*	$0.0	$3.4	$4.0	$4.0
For transient accommodation tax:					
Lodge and Business Center room revenues	*Exhibit 2-3*	$0.0	$3.2	$3.7	$3.7
Total TAT collected	*7.25% of room revenues*	$0.0	$0.2	$0.3	$0.3
For individual income taxes:					
Net new personal income earned	*Average annual in preceding period*				
Development employment	*Exhibit 3-7 (total personal earnings)*	$58.8	$68.1	$49.0	$0.0
Operational employment	*Exhibit 3-10 (total personal earnings)*	$28.4	$85.5	$119.4	$114.8
Av. personal earnings/FTE job -					
Development employment	*Exhibit 3-7 (total personal earnings), not in millions >>*	$58,000	$58,000	$58,000	$0
Operational employment	*Exhibit 3-10 (total personal earnings), not in millions >>*	$47,000	$50,000	$50,000	$50,000
For other State taxes:					
FTE in-migrants to State	*FTE non-primary residents + employees and their dependents: Exhibit 4-1*	280	600	800	780

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 U.S. Department of labor, Bureau of Labor Statistics, "Consumer Spending Patterns in Honolulu: 2001-02", released April 20, 2004 at www.bls.gov/ro9/cexhono.htm (still latest available on bls site as of July 2011). Estimate uses study findings showing 77.6% of pre-tax income of household units was spent, of which 75.1% were on items likely subject to Hawaii Gross Excise Tax. Excludes spending on shelter (owned dwellings), cash contributions, personal insurance and pensions. Applied to estimated in-migrant households and average of personal earnings for 2020, 2030 and 2040 for operational employees, as shown. Excludes potential household income from other household members.

Exhibit 5-4
Projected State Government Revenues
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions)	2022	2032	2040	After 2040
General excise taxes, on:					
Development[1]		$2.0	$2.4	$1.7	$0.0
Real estate sales and marketing	*4.0% of costs*	$0.1	$0.1	$0.1	$0.0
Lodge and Business Center revenues	*4.0% of revenues*	$0.0	$0.1	$0.2	$0.2
Spending by Project's non-primary residents	*4.0% of spending*	$0.7	$1.6	$2.2	$2.2
Spending by in-migrants to State	*4.0% of employee & dependent spending*	$0.0	$0.0	$0.0	$0.0
Transient accommodations tax, on:					
Lodge and Business Center revenues	*55.2% State share of total collections*[2]	$0.0	$0.1	$0.1	$0.1
Individual income taxes[3]:					
Development employees	*4.7% effective tax rate on av. family AGI estimated at $80,000 based on Ex.3-7*	$2.8	$3.2	$2.3	$0.0
Operational employees	*4.8% effective tax rate on av. family AGI estimated at $68,000 based on Ex.3-11*	$1.4	$4.1	$5.7	$5.5
Other taxes and revenues from in-migrants[4]	*$537 per person*	$0.2	$0.3	$0.4	$0.4
Total, additional revenues		$7.2	$12.0	$12.8	$8.4

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 Based on 4% on 100% of professional services and 60% of construction costs, plus a wholesale construction materials tax of 0.5% against 40% of construction costs.

2 2011 Legislature passed a cap on total amount of TAT collections to be shared with counties, so this amount could effectively be higher.

3 Based on average family incomes for all Project-related job holders as shown previously, and on 2010 Tax Table for married taxpayers filing joint returns, as shown at http://www.state.hi.us/tax/d_10table_p09.htm. Adjusted Gross Incomes (AGI) assumed to be 25% less than total average family earnings, considering potential deductions.

4 Based on miscellaneous FY 2009 State tax revenue receipts as reported by State of Hawaii, "Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2007," governmental funds, statement of revenues, expenditures, and changes in fund balances (pg. 39). Includes tobacco and liquor taxes, liquid fuel tax, motor vehicle weight & registration tax, and fines & forfeitures. Excludes licenses, franchise tax, rental motor vehicle surcharge tax, public service companies tax, tax on premiums of insurance companies and other fees and taxes.

Exhibit 5-5
Hawaii County Governmental Expenditures
Net of Intergovernmental Revenues (State and Federal)
Per Capita in Fiscal Year July 1, 2009 to June 30, 2010

	Expenditures ($thousands)	Service population[1]	Expenditures (not in thousands) per: Resident	Visitor
Current expenditures:				
General Government	$40,585	215,000	$189	$189
Public Safety	$108,798	215,000	$506	$506
Highways and Streets	$20,221	215,000	$94	$94
Health, education and welfare	$25,519	185,100	$138	$0
Culture and recreation	$17,266	215,000	$80	$80
Sanitation	$35,674	215,000	$166	$166
Pension and retirement contributions	$28,509	185,100	$154	$0
Employees' health insurance	$23,573	185,100	$127	$0
Other post-employment benefits	$15,700	185,100	$85	$0
Miscellaneous	$4,773	215,000	$22	$22
Debt service:				
Principal (majority from bond redemption fund)	$20,720	215,000	$96	$96
Interest	$14,584	215,000	$68	$68
Capital outlays (majority capital projects)	$100,653	215,000	$468	$468
Subtotal	$456,575		$2,194	$1,690
Less: Intergovernmental revenues (Federal and Stat	($77,613)	215,000	($361)	($361)
Proprietary funds[2]:				
Kulaimano Elderly Housing Project (incl. interest)	$56	185,100	$0	$0
'O'uli Ekahi affordable Housing Project	$58	185,100	$0	$0
Subtotal	$114		$1	$0
Total, in 2009/2010 dollars	**$379,076**		**$1,833**	**$1,329**
Total, in 2011 dollars, based on increase of[3]		1.3%	**$1,857**	**$1,346**

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Based on governmental and proprietary fund financial statements. Excludes fiduciary funds since they represent resources held for the benefit of parties outside of the County. Line items may have debt service and employee benefit expenses within each, but exclude depreciation.

1 Resident population as of April 1, 2010 by U.S. Census Bureau, 2011, Summary File Table P1: de facto population based on residents plus average daily visitor census, as estimated by State of Hawai'i, Department of Business, Economic Development and Tourism, Research & Economic Analysis Division, Hawaii Tourism Authority, "Monthly Visitor Statistics."

2 Enterprise funds reflecting business-type activities at senior housing projects near Hilo and in Waimea, respectively. Figures shown are change in net assets, or operating revenues plus investment income, less operating expenses and interest expenses.

3 Based on average of 2nd half 2009 and 1st half 2010 vs. 2nd half 2010 Honolulu CPI-U, as reported by U.S. Department of Labor, Bureau of Labor Statistics at http://data.bls.gov, accessed July 2011.

Source: Department of Finance, County of Hawaii, "Comprehensive Annual Financial Report: Fiscal Year Ended June 30, 2010," December 30, 2010. Fund Financial Statements, as shown on pages 32-42

Exhibit 5-6
State of Hawai'i Government Expenditures
Net of Intergovernmental Revenues (Federal)
Per Capita in Fiscal Year July 1, 2008 to June 30, 2009

	Operating expenditures ($thousands)	Service population[1]	Expenditures (not in thousands) per: Resident	Visitor
Governmental funds[2]:				
General government	$597,210	1,471,000	$406	$406
Public safety	$435,414	1,471,000	$296	$296
Highways	$442,421	1,471,000	$301	$301
Conservation of natural resources	$120,693	1,471,000	$82	$82
Health	$798,026	1,471,000	$543	$543
Welfare	$2,119,481	1,291,300	$1,641	$0
Lower education	$2,454,666	1,291,300	$1,901	$0
Higher education	$878,127	1,291,300	$680	$0
Other education	$29,912	1,291,300	$23	$0
Culture and recreation	$107,302	1,471,000	$73	$73
Urban redevelopment and housing	$179,819	1,291,300	$139	$0
Economic development and assistance	$169,547	1,291,300	$131	$0
Housing	$1,909	1,291,300	$1	$0
Other	$1,175	1,471,000	$1	$1
Debt service	$401,722	1,471,000	$273	$273
Less: Intergovernmental revenues	($2,090,058)	1,471,000	($1,421)	($1,421)
Subtotal	$6,647,368		$5,071	$553
Proprietary Funds (Business-type activities)[2]:				
Airports	$58,043	1,471,000	$39	$39
Harbors	$51,429	1,471,000	$35	$35
Unemployment compensation	$247,902	1,291,300	$192	$0
Nonmajor proprietary fund	$34,022	1,471,000	$23	$23
Subtotal	$391,396		$290	$98
Total, in 2008/09 dollars	**$7,038,764**		**$5,360**	**$651**
Total, in 2011 dollars, based on increase of[3]		2.9%	**$5,517**	**$670**

Notes: Study benchmark dates refer to periods beginning or ending late in each respective year.

Based on governmental and proprietary fund financial statements. Excludes fiduciary funds since they represent resources held for the benefit of parties outside of the State.

General government includes legislative expenses; line items may also have debt service and employee benefit expenses within each. Excludes expenses of "Component Units" including the University of Hawaii, Housing and Community Development Corporation of Hawaii, Hawaii Health Systems Corporation and Hawaii Hurricane Relief Fund. The first three charge for services, and receive capital and operating grants and contributions.

1 Estimated resident population for January 1, 2009 estimated based on data from the U.S. Census Bureau, Population Estimates Program estimates for July 1, 2008 and July 1, 2009; average daily visitor population based on Hawaii State Department of Business, Economic Development and Tourism, Research & Economic Analysis Division, Hawaii Tourism Authority, "Monthly Visitor Statistics," 2010.

2 Expenditures incurred within the General, Capital Projects, Med-Quest Special Revenue and Other Governmental Funds.

3 Enterprise funds reflecting business-type activities. Figures shown are change in net assets before capital contributions, or operating revenues plus nonoperating revenues or expenses (including interest income and expenses and federal grants), less operating expenses.

3 Based on 2nd half 2008 and 1st half 2009 vs. 2nd half 2010 Honolulu CPI-U, as reported by U.S. Department of Labor, Bureau of Labor Statistics, accessed July 2011.

Source: State of Hawaii, Department of Accounting and General Services, "State of Hawaii Comprehensive Annual Financial Report For the Fiscal Year Ended June 30, 2009," October 20, 2010.

Exhibit 5-7
Annual County Government Expenditures
Attributable to Visitors and Population In-Migrating
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions)			2022	2032	2040	After 2040
Bases for County projection -							
FTE in-migrants to County	*Non-primary residents, employees and dependents (Ex. 4-1)*			*360*	*790*	*1,050*	*1,040*
Visitors from off-island	*Exhibit 2-3*			*-*	*124*	*133*	*133*
Annual expenditures -							
FTE in-migrants to County	*$1,857*	*per person, ref:*	*Exhibit 5-5*	$0.7	$1.5	$1.9	$1.9
Visitors from off-island	*$1,346*	*per person, ref:*	*Exhibit 5-5*	$0.0	$0.2	$0.2	$0.2
Subtotal new County expenditures				$0.7	$1.6	$2.1	$2.1

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

Exhibit 5-8
Annual State Government Expenditures
Attributable to Population In-migrating
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference (not in millions)			2022	2032	2040	After 2040
Bases for State projection -							
FTE in-migrants to State	*Non-primary residents, employees and dependents (Ex. 4-1)*			*280*	*600*	*800*	*780*
Visitors from out-of-State	*Exhibit 2-3*			*-*	*52*	*56*	*56*
Annual expenditures -							
FTE in-migrants to State	*$5,517*	*per FTE person, ref:*	*Exhibit 5-6*	$1.5	$3.3	$4.4	$4.3
Visitors from out-of-State	*$670*	*per FTE person, ref:*	*Exhibit 5-6*	$0.0	$0.0	$0.0	$0.0
Subtotal new State expenditures				$1.5	$3.3	$4.4	$4.3

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

Exhibit 5-9
County & State Government Revenue and Expenditure Comparison
2022, 2032 and 2040 (2011 dollars, in millions, except as noted)

	Basis/reference	2022	2032	2040	After 2040
Hawaii County:					
New revenues	*Exhibit 5-2*	$5.7	$10.8	$12.9	$12.9
New expenditures	*Exhibit 5-7*	$0.7	$1.6	$2.1	$2.1
Net additional revenues		$5.1	$9.1	$10.8	$10.8
Revenue ÷ expenditure ratio[1]		8.6	6.6	6.1	6.1
State of Hawaii:					
New revenues[2]	*Exhibit 5-4*	$7.2	$12.0	$12.8	$8.4
New expenditures	*Exhibit 5-8*	$1.5	$3.3	$4.4	$4.3
Net additional revenues		$5.6	$8.7	$8.4	$4.1
Revenue ÷ expenditure ratio[1]		4.6	3.6	2.9	2.0

Note: Study benchmark dates refer to periods beginning or ending late in each respective year.

1 New revenues divided by new expenditures. Calculated where denominator (additional expenses) exceeds zero

2 Excludes potential income taxes from any operating entities and GET on ground lease rents

ECONOMIC AND FISCAL IMPACT ASSESSMENT FOR KALOKO MAKAI

Appendix

Appendix 1: Multipliers for Select Industries

	Type II final demand multipliers		Type II direct effect multipliers (for indirect & induced impacts)	
	Earnings	Job	Earnings	Job
Agriculture	0.66	36.6	1.77	1.44
Mining & Construction	0.65	19.70	1.79	2.23
Food processing	0.51	21.6	3.05	3.05
Other manufacturing	0.34	10.2	1.97	2.36
Transportation	0.57	17.7	2.26	2.55
Information	0.52	13.6	1.71	2.15
Utilities	0.33	8.2	2.38	4.17
Wholesale trade	0.55	17.1	1.76	1.96
Retail trade	0.57	24.4	1.69	1.51
Real estate & rentals	0.22	9.1	4.07	2.91
Professional services	0.81	23.3	1.69	1.97
Business services	0.83	30.9	1.69	1.62
Educational services	0.83	33.2	1.70	1.57
Health services	0.77	24.1	1.71	1.91
Arts & entertainment	0.77	37.4	1.59	1.38
Accommodations	0.63	20.0	1.90	2.06
Eating & drinking	0.60	30.5	1.99	1.54
Other services	0.69	30.7	1.80	1.54
Government	0.85	24.7	1.40	1.54
Average	**0.62**	**22.8**	**2.00**	**2.08**

Source: State of Hawaii, Department of Business, Economic Development and Tourism, "The 2002 State Input-Output Study for Hawaii," June 2006 (as revised from May 2006), Table 2.4.

On generator, specify use of 316 stainless steel on any and all exterior plates, bolts, nuts, piping, etc.

On generator exhaust, specify a high heat, high grade paint for rust protection. The top cap should be SS metal to prevent corrosion**(the entire project should look at ways that we are doing this once based on the high salt environment – it's either pay now or pay later and I prefer to pay now and do things once with high quality)**

The generator day tank should be on skids and mounted under generator just like at PuuMahoe

Generator louvers should be like Mahoe page A3 and M1, all motorized, S/S bird screen and filters.

Pipe support details should be same or similar to Mahoe drawings on page M4

The roof line on the door side extend from 3 ' to 4 ' to cover the entire sidewalk on that side of building

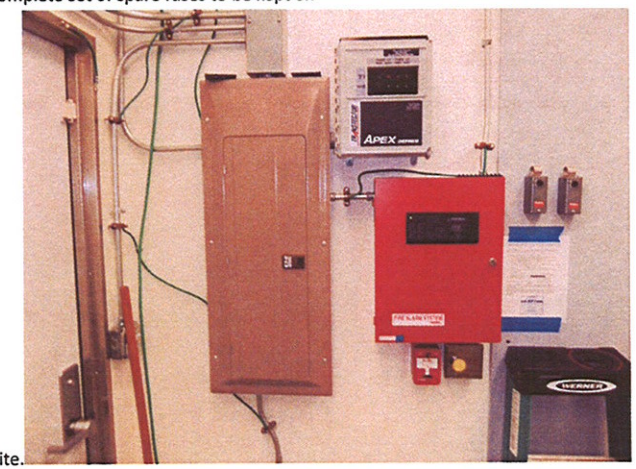
6" thick sidewalks with 2 degree slope away from bldg

Dry well – design same like Mahoe page E3

Install a ground well test point, like Mahoe – refer to page E3 on Mahoe drawings

Lightning and surge protection for main panel similar to that listed on Mahoe drawing on page E2

Transient protect as on page E5. The APEX in this picture is an example and have vendor supply a complete set of spare fuses to be kept on



site.

Ground grid exterior (RF ground) as well as interior grounding likeMahoe on page E5

Send spec on Hyatt 3 ton and install like Mahoe as listed on page M3

Backer boards on all radio room walls (all the way around) , ¾ inch, 4X8, with AC finish and paint to match. Mount boards 1 foot above floor in parallel layout. One plywood sheet should be mounted in battery room, immediately to the left of the entry door

Buss bar grounding on the exterior of microflect should be as indicated on page 9 A4 details on Mahoe plans

Microflect 8 port (2X4) Model # B1338 (There will be 2 of these on the building. Check with Jeff on locations)

Two side-by-side- mounted Polyphaser 8-Peep-M

Grounding detail for site, refer to Mahoe E3 and E4

AC (get spec from Hyatt job)

Appendix Q

Kaloko Makai Social Impact Assessment
John M. Knox & Associates, Inc.
June 2011

J•M•K JOHN M. KNOX & ASSOCIATES, INC.

KALOKO MAKAI SOCIAL IMPACT ASSESSMENT

Volume 1: Background and Community Issues

May 3, 2011

Prepared for:
Stanford Carr Development, LLC.

Prepared by:
John M. Knox & Associates, Inc.

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FOREWORD

John M. Knox & Associates was engaged to prepare a social impact assessment of the proposed Kaloko Makai mixed-use commercial and residential development in Kona. In accord with Kona Community Plan principles of providing housing choices, recreation opportunities, directing growth patterns towards compact villages and encouraging a diverse and vibrant economy, Stanford Carr Development proposes a 1,142-acre development with a strong emphasis on residential development.

The work is presented in three volumes:

1. The current Volume 1 presents background socio-economic conditions and results of a community interview process to surface key issues.
2. Volume 2 is an analysis of housing issues, largely prepared by subcontractor Tom Dinell (Dinell Associates). Mr. Dinell is Emeritus Professor in the University of Hawai'i Mānoa's Dept. of Urban and Regional Planning, teaching courses on housing there.
3. Volume 3 contains results of a 2009 "North Kona Community Planning Survey" that focused on awareness of the new Kona Community Development Plan (CDP) and extent of agreement with key element relevant to the proposed project.

We should note that elements of the project evolved as our studies were completed. Two potential components ***not addressed*** were:

- A possible State Judiciary complex on the project site – because Kaloko Makai was one of 11 potential sites at the time Vol. 1 community interviews were done, we elected not to discuss it because of what seemed its low probability. As of this writing, Kaloko Makai is still one of six remaining sites under consideration.
- A possible small (120-unit) hotel to help serve the proposed hospital, as well as the Judiciary complex if it materializes.

Additionally, other aspects of project planning – such as tentative phasing and changes to road alignments – have continued to evolve during and after the community interview process. Interviewees were given a Project Description (Appendix B) that was less specific than plans available as of this writing (May 2011) and also showed more industrial land than is now planned.

SUMMARY AND ANALYSIS OF VOLUME 1 RESULTS

A. Background Conditions

The report provides extensive description of existing and projected socio-economic conditions for West Hawai'i (defined as North and South Kona, as well as South Kohala) using secondary data such as the U.S. Census and public opinion surveys. At least three broad conclusions can be derived from this analysis –

(1) West Hawai'i is now, and is projected to continue as, Hawai'i Island's economic engine. Most of the island's private-sector businesses and jobs are now located there, and the clear trend is for further development. Housing options will be needed so that Kona residents can live and work in the same place.

(2) Historically, the island has undergone sharp cycles in its economy. The economy briefly avoided its usual mid-decade downturn, resulting in a virtually unprecedented full decade of steady economic growth – growth associated in opinion polls with resident complaints about cost of housing, traffic, and perceived government failure to assure that infrastructure keeps up with growth. However, the Great Recession thereafter hit West Hawai'i and other Neighbor Island resorts particularly hard.

(3) Socially and demographically (and arguably architecturally), West Hawai'i is looking more and more like California, especially with the recent boom in vacation home development. However, Native Hawaiians comprise the area's second-largest ethnic group. The West Hawai'i region is important in Native Hawaiian history, and vice-versa. While the nature of this project mostly does not lend itself to any particular cultural flavor, the possible preservation and reinvigoration of the historic Kohanaiki ("Road to the Sea") Trail is an important exception.

B. Community Issues and Perceived Impacts

Approximately 30 community leaders or other stakeholders were interviewed in November 2010 and February 2011 in order to surface issues and concerns regarding the proposed project. This type of process does not comprise the sort of representative cross-sample of the community as the telephone survey discussed in Volume 3, but does allow for more in-depth discussion and probing of perceptions.

1. Consultant Comments on Context of Interviews: The West Hawai'i community has been whip-sawed by the recent cycle of extremely rapid prolonged growth, followed by a deep (and also prolonged) economic downturn. Some people remain very focused on the historical challenges posed by rapid growth, and assume that any new proposal will trigger those same challenges. However, we also encountered a strain of economic anxiety and concern about the future – a fear that some mix of structural economic change and worsening air quality (i.e., vog) may permanently affect the area's

prospects – that we never came across in our previous three decades of social impact interviews there. In the mid-2000's, there was a desire for "growth-absorbing" projects that would provide housing and needed community amenities (which is essentially what the Kaloko Makai proposal does), as opposed to "growth-inducing" economic development. Now, some people asked, "Can't this project include even more jobs?"

At either end of this spectrum are people who look at a proposed large new mixed-use residential development with limited enthusiasm – the first out of apprehension that "If you build it, they will come," and the second out of the opposite apprehension that nobody at all will be coming to buy these units. The first group is inclined to oppose the project (or any others that would either cause or reflect further growth), while the second is not so much opposed as uncertain of need. Both groups were minorities among our particular interviewees – with more people in the middle – but they illustrate the varying shades of impact on attitudes from the sustained economic downturn.

Beyond the immediate economic situation, it is important to understand two key pieces of historical context:

1. There have been several decades in which rapid growth has outstripped the provision of key infrastructure – particularly roads, but also things like schools, parks, water/wastewater treatment, and even sufficient housing for local residents because much of the growth has been focused on resorts and resort-type housing.

   This has generated ***substantial distrust***, not only of developers but also (and sometimes more so) of State and County government agencies seen as failing to provide that infrastructure and/or failing to enforce conditions imposed on developers. This distrust manifests itself in many ways – different ways for different people – but one of those ways is to care more about nailing down infrastructure considerations than almost anything else, including housing affordability. (Again, there tends to be some suspicion that proposed housing developments will really <u>be</u> "affordable" to any significant part of the resident population.)

   For example, some interviewees for this project felt the developer should be required to construct and/or pay for – not just partner with other entities to assure provision of – elements such as the project's link for the Ane Keohokalole ("Mid-Level") Highway, the proposed hospital, and actual school structures, despite possible impacts on housing prices. A project such as the proposed Kaloko Makai development will therefore need to spend particular time explaining its market assumptions and underlying financial structure to a skeptical community that includes many people at least moderately familiar with real estate development.

2. In an attempt to remedy past problems, many of the community's most active members have been involved in creating and/or overseeing implementation of the Kona Community Development Plan (CDP). As one of the first major proposed developments under the new Kona CDP, Kaloko Makai has begun to receive scrutiny as to Plan compliance – especially because its planning consultant (the Wilson Okamoto Corporation) was also the prime consultant for the Kona CDP.

One key element of scrutiny involves the proposed hospital. The Kaloko Makai area is currently designated on the CDP as a "Neighborhood Transit-Oriented Development (TOD) Center," which would not permit the extent of development being proposed. However, the CDP also says a Neighborhood TOD Center will "automatically" be granted "Regional Center" status, permitting higher densities and more development, if a new full-service hospital is included. Therefore, the development team can expect pointed questions about the certainty and exact timing of the hospital. Also, because there have been other proposed new medical facilities (not all of them full-service hospitals), it will likely be critical for the developer to show not only that Kaloko Makai's hospital will likely be the first or the only actually to materialize, but also that it is still filling a vital community need.

Beyond the hospital, the development team will need to respond to questions from the community that more typically come from local government planners – detailed aspects of urban design, green spaces, exact placement of transit stops, etc. These were not necessarily the most important issues for the bulk of our interviewees, but the fact that key community leaders have invested so much time and attention in them means their importance is more likely to grow than to diminish.

2. Response to Overall Plan: Interviewees were excited, or at least cautiously optimistic, about many of the proposal's specific components. ***Most interviewees spoke to possible changes to the current proposal, instead of discounting or rejecting the entire plan.*** That is, they did not simply take a stand for or against the Project, but offered meaningful insight into how some of its components could be adjusted or changed to make it fit into the area, or be more suitable to area residents. The majority of our particular interviewees felt it made more sense to plan for growth than to resist it.

The ***most frequent concerns*** expressed about the plan in general were:

1. As noted above, conformity to the Kona CDP – Regional versus Neighborhood TOD Center status and other urban design specifics.

2. Scale of the project (5,000 units) permitted under the "Regional Center" designation. Even though people intellectually recognized the proposal envisions a 30-year buildout, the visceral impact of "5,000 units" was difficult for many people to absorb.

Things that people tended to like most about the project included:

1. Possible economic contributions – i.e., 30 years' worth of construction jobs, plus work at the hospital and retail areas, as well as a greater tax base.

2. Infrastructure improvements, most particularly another extension to the needed Mid-Level Road.

3. Green space – the unique 150-acre dryland forest preserve and the restoration and integration of the Kohanaiki "Road to the Sea" Trail.

3. Issues About (Other) Specific Plan Elements:

Residential Housing: Despite concerns about project size, there was substantial agreement that housing is needed (in the future if not immediately), and employers in particular welcomed a prospective large addition to supply. The great concern was, "Will this really be affordable?" One of the most recurring themes in the interviews was the feeling that County guidelines for the "affordable" definition did not seem to produce enough housing that workers in West Hawai'i's core service industry can really afford. Related to this was the suggestion of inequity in housing development – provision of housing for off-islanders rather than "local" people.

Phasing: Though a detailed phasing plan was not available at the time of the interviews, most people approved the general information then provided – i.e., the project would begin with key infrastructure and with industrial/commercial property along Queen Ka'ahumanu Highway. There was, of course, concern that infrastructure would actually materialize on time as proposed.

Hospital: Again, there were questions as to whether and when this would actually materialize (and some feeling there could be competition unforeseen when the Kona CDP was finalized). However, almost everyone agreed the current hospital in South Kona is inadequate for both present and future needs. And some people urged that the hospital have more of an economic development – e.g., include a medical research component and/or be a specialty hospital drawing in off-island clientele.

Roads and Infrastructure: Again, the plans generally seemed good to people, and the Mid-Level Road was seen as vital. The question was whether and when the plans would be carried out. There were some specific concerns about exact road alignments and a desire for more information about water/wastewater facilities.

Retail/Commercial Component: The location of the bulk of such activity on Queen Ka'ahumanu Highway, by the existing Kaloko Industrial Park, seemed appropriate to most people. There were questions about the extent of demand for the amount of land initially planned by the developer (since scaled back) and some concern about impacts on local groundwater and coastal waters.

Schools: Most people approved the proposed one middle-school and two elementary school sites. Some people so distrusted government follow-through on building the structures in a timely way that they thought the developer should build those.

Trails, Parks, and Open Space: While the dryland forest was seen as a particularly valued project amenity, there was a strong desire for most project green areas to be useable by the community, not just passive open space. The Road to the Sea trail was also seen as a highly desirable characteristic, though there was a feeling by trail stakeholders that more work needs to be done to locate and define the actual historic trail alignment. (There had been some issues on this matter in regard to Stanford Carr Development's Kaloko Heights project; stakeholders said the current project is at least starting out in a much more positive way, with greater consultation.)

4. Kaloko-Honokōhau National Historical Park: The northern part of the Kaloko-Honokōhau National Historical Park is located directly across Queen Ka'ahumanu Highway makai of the Project site. It is likely the most sensitive "neighbor" to the proposed project, and therefore we made the effort to interview National Park Service (NPS) officials. For the most part, the NPS interviewees directed us to their letter in response to the project's Environmental Impact Statement Preparation Notice, and so Table 3.5 of this report summarizes issues raised in that latter – primarily physical environmental impacts but also concerns about cultural resources, connectivity to the Park through the Road to the Sea Trail, and cumulative impacts on Park resources.

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1. INTRODUCTION

1.1 Purpose and Scope of Report

This report is an assessment of potential social impacts of the proposed "Kaloko Makai" project in the Kealakehe ahupua'a of North Kona, County of Hawai'i. It has been prepared for the project developer – Stanford Carr Development LLC. – and is intended to be an appendix to the project Environmental Impact Statement (EIS) being prepared for Stanford Car Development LLC by Wilson Okamoto Corporation.

Social impact assessments are made in order to identify and disclose information of use to decision makers and citizens, as they evaluate the implications of proposed development. Because the "social" realm is extensive and not precisely defined, assessments typically contain substantial attention to community issues and perceptions, in addition to consultant analyses of selected issues.

The report consists of three chapters:

(1) The current Chapter 1 contains introductory material;

(2) Chapter 2 presents data on historic, existing, and anticipated future socio-economic conditions in the West Hawai'i study area.

(3) Chapter 3 – in many ways the heart of this study – reports on issues and concerns about the project itself.

1.2 Project Description

The project is described at length in the overall EIS. Briefly –

Size and Location: About 1,142 acres, extending mauka from Queen Ka'ahumanu Highway. The Queen Ka'ahumanu portion is located just north of the existing Kaloko Industrial Park. Hina Lani St. forms the southern (Kailua-side) border of the lower part of the property, but the upper part includes land on both sides of Hina Lani.

Current Use and Land Use Designations: Vacant and undeveloped. County General Plan – Urban Expansion and Conservation. Keāhole to Kailua Development Plan – Urban Expansion, Residential Village, and Golf Course. (*The current General Plan "Conservation" designation was for a once-planned golf course that would be deleted under the new plan; the developer will ask the County for Urban designation of the former golf course land after State Land Use approval.*) Kona Community Development

Plan (CDP) indicates the general Kaloko Makai area as one of the designated "villages" for transit-oriented development.

State Land Use now Conservation, Agricultural, and Urban – request is to change about 224.5 acres from Conservation to Urban and 728 acres from Agricultural to Urban. (The State Urban designation would follow the County's Kona CDP designation as an urban area.) A 150-acre dryland forest preserve will be created. An EIS is being prepared.

Development Concept/Phasing: Consistent with the Kona CDP, Master-planned residential community, with supporting commercial, educational, recreational, open space, and related infrastructure. Primarily a residential development, with some business/commercial job centers. To be developed in three phases (or "villages") over an estimated 28 years. First homes by 2015.

Key Components:

- Residential - At full development about 5,000 new single- and multi-family residential units at low (up to 3 units per acre) and medium (up to 20 units per acre) densities.
- Commercial – About 120 acres in various locations. Largest would be a business park that may potentially include Scientific Research & Development facilities, retail, and a regional hospital along the Mid-Level Road. Mixed-use areas of the project are designed to include residential and commercial uses within close proximity of each other (this may include affordable residential on top of a variable commercial component).
- Preservation / Open Space / Recreation – In addition to the dryland forest (150 acres of preserved forest and natural habitat), the project will preserve a historic trail which is commonly referred to as the *Road to the Sea*. While the boundaries of this trail (within the Kaloko Makai property) have yet been determined, it is evident that the trail originates in the mid-section of the property just east (makai) of Kaloko Makai (in the site, properly named Kaloko Heights) and meanders down through the KM parcel. A series of archaeological outcroppings have also been noted in the Archaeological Inventory Report. Depending on the nature of each archaeological site buffer zones will be provided accordingly.
- Facilities and Roads – Land set aside for elementary and middle schools. Active parks and recreation areas. The proposed Mid-Level Road would cut across the project.

Estimated Housing Prices and Types *(Current Developer Assumptions)*:

- "Affordable" Component – Will be 20% of units (about 1,000), targeting residents with income levels between 60%-140% of area median income. Based on 2007 HUD numbers, that would include at least some units for rental to 3-person low-

income families at $972/month and for sale at $152,600 (2007 numbers). Final mix of affordable not yet known.

- Market Component – A wide range of products, in today's dollars from mid to high $200,000's up to $1,000,000. The target market is the local rather than the offshore buyer. Overall, the project is intended to respond to already-planned economic growth rather to generate more of it.

2. EXISTING AND ANTICIPATED FUTURE SOCIO-ECONOMIC CONDITIONS

This section provides background description of the overall area assumed to be affected by potential project development – the "study area" – and projected changes occurring with or without the project. Covered in this section are:

- Definition of the "study area;"
- Overview of population and settlement patterns;
- Demographic and social characteristics;
- Business characteristics and tourism growth;
- Workforce, labor supply and income; and
- General community issues and attitudes.

2.1 Definition of Study Area

We consider the *primary* Study Area to be the district of North Kona, which is equivalent to the U.S. Census Bureau's "County Census Division" (CCD) of North Kona. The *overall* Study Area – "West Hawai'i" – would also include the CCDs of South Kona and South Kohala.[1] (See Figure 2.1), which also shows the general location of the Kaloko Makai project in North Kona.)

Within North Kona, the 2000 Census has data for five "Census Designated Places" (CDPs) – Kalaoa, Kailua, Hōlualoa, Kahalu'u-Keauhou, and Honalo. Figure 2.1 shows the location of those CDPs within the North Kona CCD.[2] As of 2000, the Census found that North Kona's total population (28,543) was distributed as follows – 24% in Kalaoa, 35% in Kailua, 21% in Hōlualoa, 7% in Honalo, 8% in Kahalu'u-Keauhou, and just 5% in the mauka areas above the five CDPs.

Some data in this section are presented by ZIP Code areas. Figure 2.2 indicates we will be particularly interested in the Kailua ZIP 96740 (as it includes the project area), but the overall "West Hawai'i" study area also includes the Kamuela, Waikoloa, Hōlualoa, Kealakekua, and Hōnaunau ZIPs.

[1] Between 1990 and 2000, the U.S. Census Bureau made some very minor boundary adjustments among the West Hawai'i CCDs. We ignore those changes when comparing historical data from the Census – i.e., we compare 1990 and 2000 populations for "North Kona" despite the slightly changed definition of the area.

[2] There are also Census Designated Places in South Kona and South Kohala, but we will focus on those closest to the project site – i.e., in North Kona.

Figure 2.1 West Hawai'i Study Area (Census Boundaries)

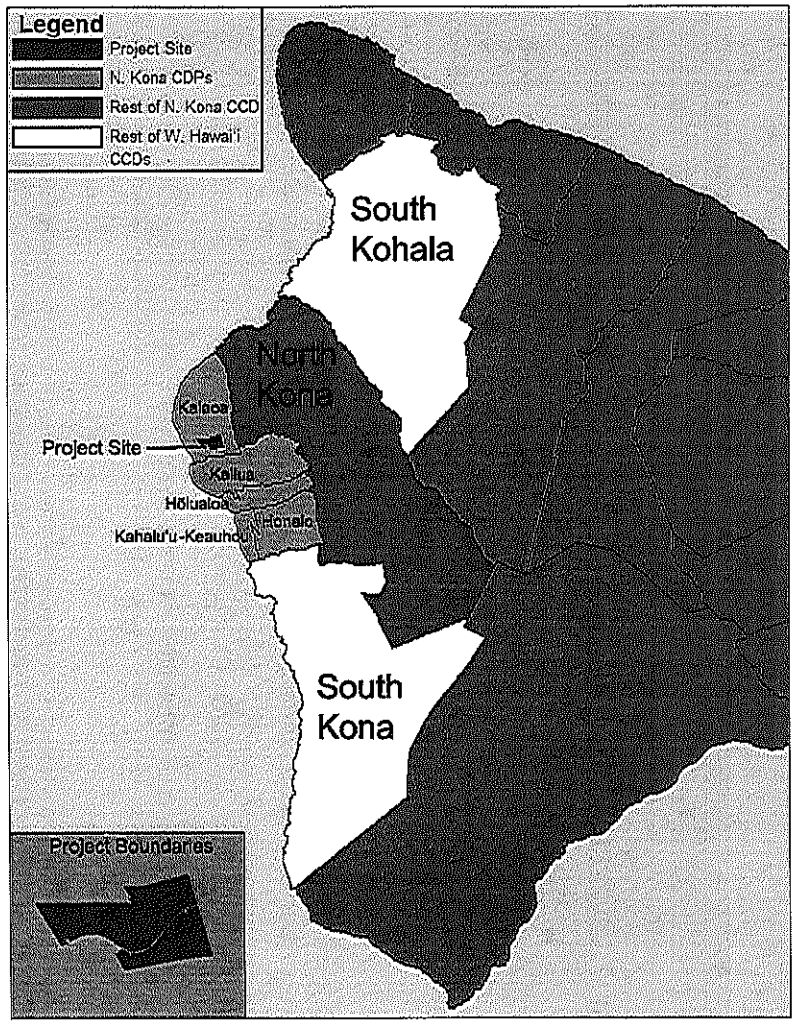
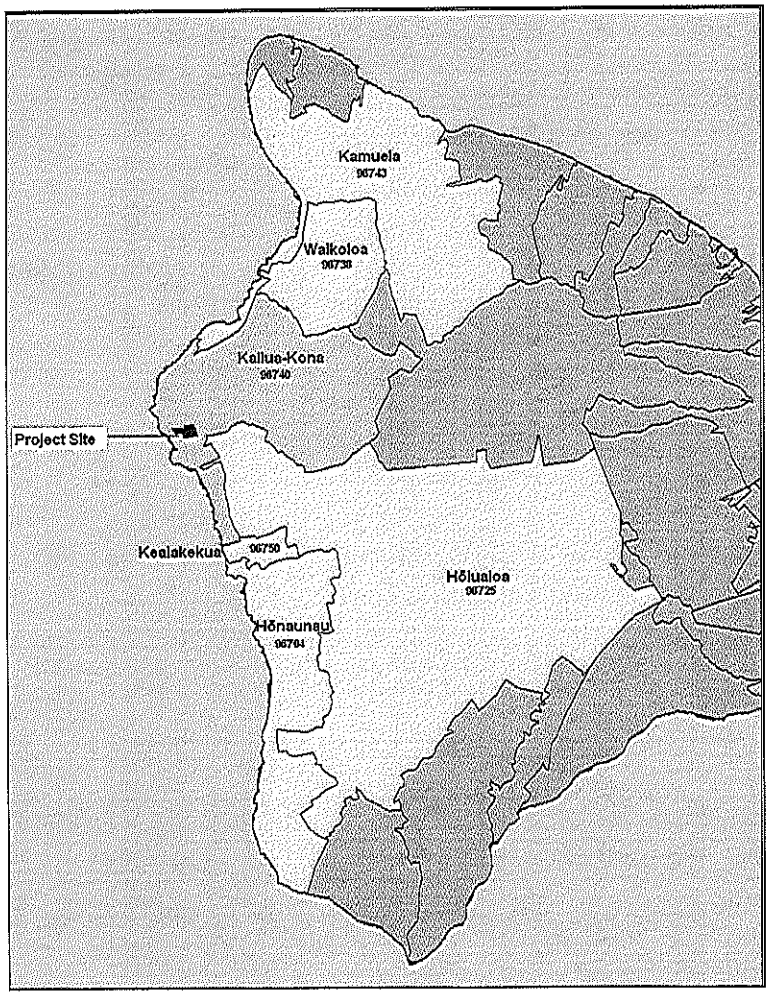


Figure 2.2 West Hawai'i Study Area (ZIP Code Boundaries)



2.2 Overview of Population and Settlement Patterns

2.2.1 Early History

The Kaloko-Makai project area is characterized by lava rock, dry scrub brush and large expanses of volcanic soil; the area shows no evidence of human settlement. There is evidence, however, that a trail to the sea, an ancient and often used transportation route, did pass through the project area[3]. Evidence of a Hawaiian fishing village makai of the project area, in Kaloko-Honokōhau, is to be found in the complex stone infrastructure in the area developed by the ancient Hawaiians. It is believed the area was a village at the time of the first known historic contact with Europeans, when Captain James Cook visited Kealakekua Bay in 1776. Later, nearby Kailua – a few miles to the south – became a part-time residence for Kamehameha I, Hawai'i's first ruling king, and for a time the area served as the capital of a newly-united nation of Hawai'i.

After the death of Kamehameha I, Kona lapsed into a period of diminished political and economic significance. Because the land in Kona is hilly and divided between dry coastal areas and steep hillsides, it did not lend itself to the sugar plantation agriculture or large-scale ranching that developed in other more prosperous areas of the island during the 19th century. In North and South Kona, most towns were small villages situated at least 1,000 feet up the slopes of Mauna Loa or Hualālai where rainfall was adequate to support coffee or other diversified agriculture. For many years, coffee and beef prices were low, and the area remained mostly rural. The political, economic, and population centers concentrated mostly in Hilo on the other side of Hawai'i Island.

A few small villages were located along the dry coast line of West Hawai'i. Kailua became a center for tourism, with particular emphasis on big-game fishing. However, most civic facilities were located mauka and south of Kailua, where they still remain.

Over the past several decades, tourism-driven economic development and extensive in-migration have precipitated an urban expansion that has altered the rural character of West Hawai'i. By 2000, the U.S. Census Bureau estimated that only about one-third of West Hawai'i's population still lived in "rural" areas, and two-thirds in "urban clusters." North Kona has become particularly urbanized, with only 22% of its population still living in areas considered "rural."

[3] According to the EISPN (Wilson Okamoto, 2010), "Significant archaeological and cultural sites, which include historic trails, will be integrated into the land plan. Archaeological and cultural sites will be protected and maintained with appropriate treatment and buffers from adjacent uses as necessary".

2.2.2 Population Levels Over Time

Figure 2.3 and Figure 2.4 on the following page provide a 120-year perspective on population growth in the county and West Hawai'i. It may be seen that an islandwide population decline after 1940 was suddenly and dramatically reversed from 1970 on, and also that West Hawai'i has been increasing as a percentage of islandwide totals. These figures are based on full-time residents only, excluding part-time residents or visitors staying in transient accommodations.

In 2000, the North Kona residential population was 28,453, and the total West Hawai'i Study Area population was 50,173. In 2010, the North Kona population reached 37,875, and the total West Hawai'i Study Area population was 65,499 –or 35.4% of the countywide population, up from 33.7% in 2000. Thus, West Hawai'i population growth in the past 20 years exceeded population growth for the rest of the county, although not as dramatically as it did from 1970 to 1990. See Figure 2.3 and Figure 2.4 on following page.

2.2.3 In-Migration

The county's population build-up during the 1990s occurred in the face of a general statewide economic slowdown. County planners hypothesized that in-migration into the County was taking place for reasons not driven by opportunities in the primary economic sectors on the island (i.e., agriculture and tourism) but was due to individuals seeking a clean environment and a rural lifestyle.[4] From 1990 to 2000, 63% of Hawai'i County's population increase was due to net in-migration, a higher percentage than for any other county. From 2000 to 2009, it was 72%, again highest of all counties.[5]

Census data for 2010 are not yet available on this topic, but earlier Census data indicate the percentage of residents born outside the state of Hawai'i rose from 39.5% in 1980 to 48.9% in 2000 for West Hawai'i (and to more than half, 51.7%, for North Kona in 2000). Comparable percentages for the rest of the county were 25.9% in 1980 and 31.0% in 2000. Thus, in-migration has clearly been funneled into West Hawai'i – North Kona in particular – more so than into the rest of the county.

More recent Census data show that Hawai'i Island's population grew faster than any other Hawai'i county from 2000 to 2010. While the statewide population grew 12.3% and the City and County of Honolulu's population grew just 8.8%, Hawai'i County's resident population grew around 24.5%.[6] This was in excess of Maui County's 20.8% growth and far ahead of Kaua'i's 14.8%.

[4] *County of Hawai'i General Plan*, February 2005, p. 1-13. However, part of the continued residential population build-up is also likely attributable to secondary economic sectors being developed and playing "catch-up" in the years following intense resort construction.

[5] *Hawai'i State Data Book 2009*, Table 1.60.

[6] U.S. Census Bureau figures posted as Table 1 on Hawai'i State Data Center website, http://Hawai'i.gov/dbedt/info/census/Census_2010/PL94-171/index_html.

Figure 2.3 County and Area Populations, 1890 – 2010

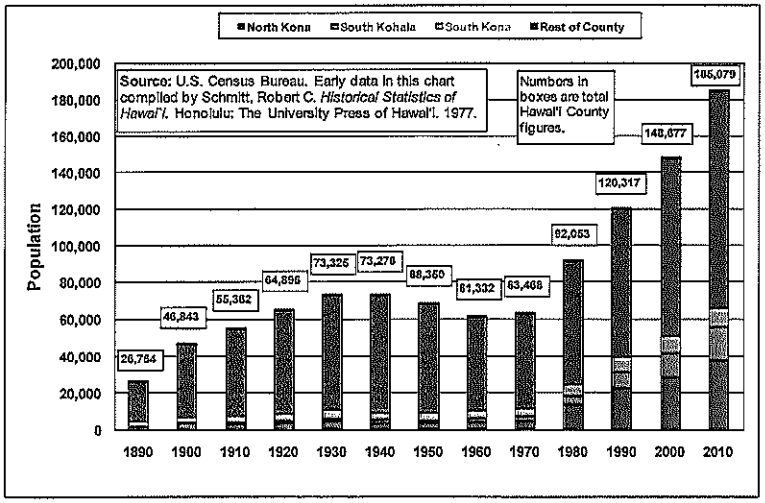
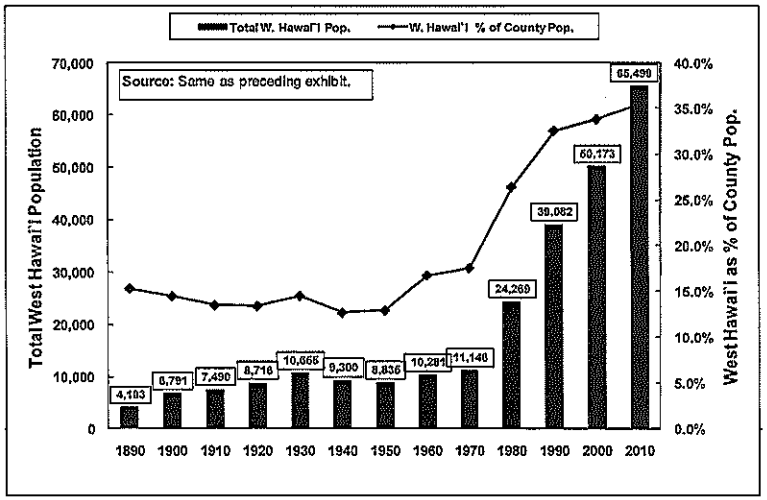


Figure 2.4 West Hawai'i Population Relative to County, 1890 – 2010



2.2.4 Housing Prices and Affordability

Housing prices in Kona have long been considered difficult for the average resident to afford, in some part because a substantial amount of new development has been targeted to the affluent off-island second-home or retiree market, with limited new supply for the actual on-island resident workforce. The Great Recession has brought down prices – particularly limiting West Hawai'i's off-island market – but also put the brakes on residential demand as well.

Figure 2.5 shows historical data from 1990 through the beginning of the recession on median prices and number of sales ("volume") for West Hawai'i vs. the nation as a whole. The median price in North Kona (including the resort-residential homes) has generally been about three times the national average. Sales volume actually started dropping before the recession but prices remained high until the recession hit, and thereafter have not dropped as rapidly as volume.

Figure 2.6 plots the same median prices against an index of "affordability" – median resale housing payments as a percentage of median family income. It shows (a) how much less affordable West Hawai'i homes have generally been than has been true for the island as a whole and the nation as a whole, and (b) the tremendous swings in housing affordability over time, with economic "good times" associated with far higher peaks in unaffordability for West Hawai'i and Hawai'i Island generally than has been true for the country as a whole.

More recently, the Kona region has ranked high among areas in the state for foreclosures.[7] Hawai'i itself was reported to be tenth in the nation in terms of number of foreclosures in February 2011. Of the 953 properties for which foreclosures were filed in February 2011, 270 were on Hawai'i Island and 92 of those were described by national consultant RealtyTrac as being in the Kailua Kona area.

Sales activity and selling prices appear to be recovering in the Kona area based on March 2011 data, though it is always advisable to use caution in predicting trends based on limited data.[8] There were 33 single family home sales in February 2011 compared to 21 a year ago, and the median price rose to $430,000 from $417,000 in February 2010. Condo sales in North Kona, however, indicated a different trend: 23 sales this year compared to 24 a year ago and a median price this past March of $149,000 compared to $247,000 last February. The condos sold this year may have been a very different class of units than those sold last year. Again, these data make no distinction between off-shore buyers and speculators, on the one hand, and local residents on the other.

In summary, it appears the real estate market in Kailua area may be close to bottoming out, but (1) recovery will be slow; and (2) housing affordable to most residents will continue to be a challenge.

[7] Magin, J.L. 2011. "Hawai'i's Foreclosure Rate Down Slightly." *Pacific Business News*, March 10, 2011, based on data from RealtyTrac. http://www.bizjournals.com/pacific/blog/2011/03/hawaiis-foreclosure-rate-gets-a.html.

[8] Andrew Gomes, 2011. "Big Isle and Kaua'i Home Sales Soar." *Honolulu Star-Advertiser*, March 8, 2011. http://www.staradvertiser.com/business/20110308_Big_Isle_and_Kauai_home_sales_soar.html.

Figure 2.5 Nationwide vs. West Hawai'i Price and Sales Volume, 1991 to Mid 2008

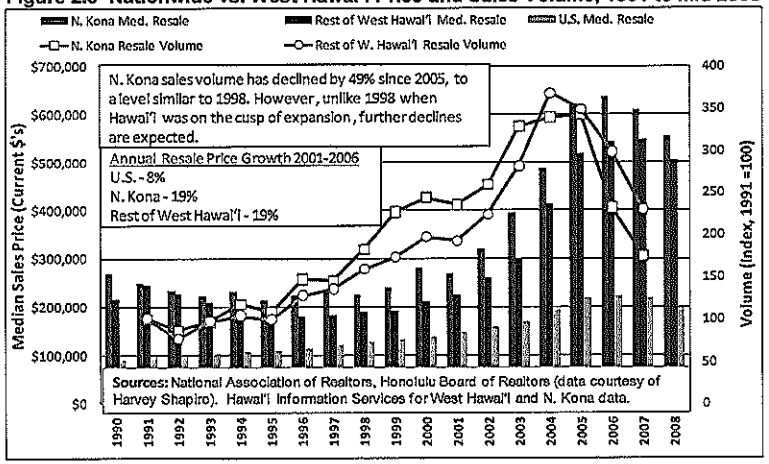
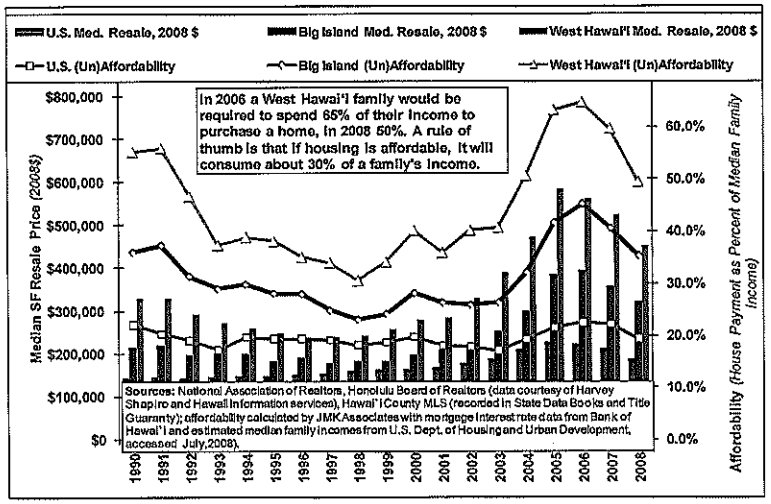


Figure 2.6 Nationwide vs. Hawai'i County vs. West Hawai'i Single-Family Home Resale Values and Affordability Levels, 1991 to Mid 2008



2.2.5 Population Forecasts

Table 2.1 provides three alternative residential population forecasts developed by the County of Hawai'i, while Figure 2.7 reflects forecasts generated by the Hawai'i State Department of Business, Economic Development, and Tourism (DBEDT). The State DBEDT numbers are for the overall island, not West Hawai'i alone. Economic growth is expected to be primarily in West Hawai'i, but actual population growth there will depend in large part on housing supply. As of 2009, the actual islandwide population was most consistent with the highest of the three alternative County forecasts, which assumes a growth rate more similar to the boom years of 1975-90 than to the slower average rate since 1990. However, in the future, the State's projected islandwide population is closer to the lower County forecast figures.

The County's *General Plan* is the one document that does hazard estimates of future resident populations by districts, though percentages are the same for the three different series of projections – i.e., 37% for West Hawai'i (see Table 2.1 below). This percentage is reasonably consistent with historical trends since 1980 (see Figure 2.4) but less consistent with trends for recent job growth located almost entirely in West Hawai'i (see later Table 2.6 and Figure 2.10.). The *General Plan* population forecasts for West Hawai'i therefore implicitly assume (although perhaps inadvertently) continued housing shortages and commuting into West Hawai'i.[9]

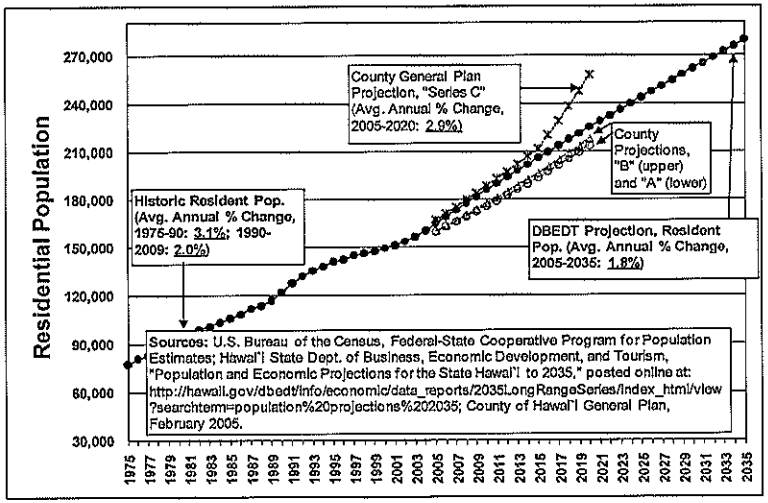
Table 2.1 Projected 2020 Resident Population, West Hawai'i and Total County

		Series A	Series B	Series C
North Kona	No.:	41,447	42,275	46,082
	% of total:	*19%*	*19%*	*19%*
South Kohala	No.:	23,947	24,426	26,625
	% of total:	*11%*	*11%*	*11%*
South Kona	No.:	13,816	14,092	15,361
	% of total:	*6%*	*6%*	*6%*
West Hawai'i	No.:	79,210	80,793	88,068
	% of total:	*37%*	*37%*	*37%*
Rest of County	No.:	134,242	136,925	149,255
	% of total:	*63%*	*63%*	*63%*
Hawai'i County Total		213,452	217,718	237,323

Source: *County of Hawai'i General Plan*, P. 1-17

[9] This is not to say the General Plan "calls for" or "builds in" housing shortages -- just that its assumed West Hawai'i population does not mesh with other evidence about probable job growth and so could be accurate only if new housing supply does not match new employment supply.

Figure 2.7 Historic Vs. Projected Hawai'i Island Resident Population



2.3 Demographic and Social Characteristics

2.3.1 Race/Ethnicity

With increased in-migration, it is generally believed that the West Hawai'i area is becoming more "White" (Caucasian) over time. However, changes in the U.S. Census wording of its question about race/ethnicity make it difficult to compare 2000 results with those of previous decades. Within the 2000 results (Table 2.2)[10] though, it may be observed that Whites are definitely more numerous in West Hawai'i, particularly in North Kona ... and also that Native Hawaiians represent the second largest ethnic group.

[10] The 2010 Census has results for "Native Hawaiian and Pacific Islanders Only," but does not presently allow breakout of mixed-race people who reported some Native Hawaiian.

This is also true for the averaged 2005-09 American Community Survey (ACS) census results, some of which are presented later. The ACS has replaced the old decennial "long-form" survey, so the 2010 Census gives results for only a few items, such as population and broad race categories. In areas such as North Kona, the ACS sample size for any one year is too small to permit reliable results, so the Census releases these only in rolling five-year averages. The averaged 2005-09 numbers are the first and, as of this writing, only such averaged numbers to be releases, but more will be forthcoming.

Table 2.2 Year 2000 Race/Ethnicity Characteristics, West Hawai'i and County

	% White Only	% Native Hawaiian*	% All Other	Total
North Kona	47.3%	25.0%	27.7%	100.0%
South Kohala	38.8%	31.3%	29.9%	100.0%
South Kona	34.1%	30.8%	35.1%	100.0%
Total W. Hawai'i	42.8%	27.7%	29.5%	100.0%
Rest of County	25.8%	29.6%	44.6%	100.0%
County of Hawai'i	31.5%	28.9%	39.5%	100.0%

* Alone or in combination with other races.

Source: U.S. Census 2000, Summary File 2

2.3.2 Age, Education, and Family Structure

As with the rest of the state and nation, West Hawai'i residents are becoming older and more educated, on average. Over the years, the educational level has increased somewhat more rapidly in West Hawai'i than in the rest of the county.

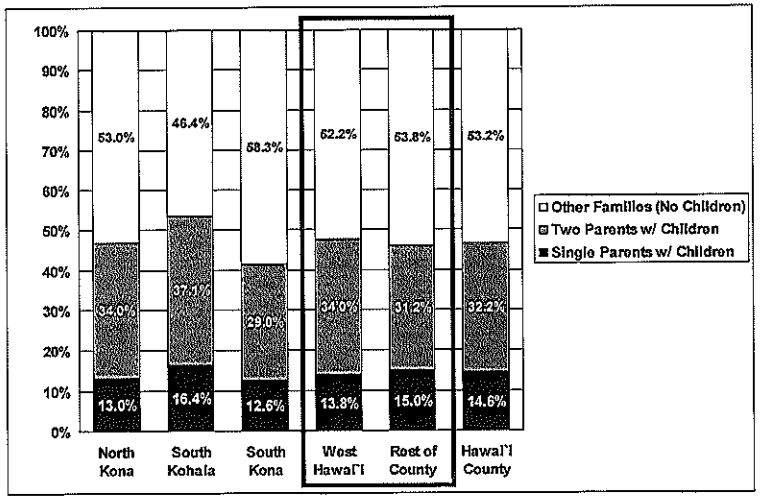
Table 2.3 Age and Education, West Hawai'i and County, 1970 – 2005-09

	Median Age (in Years)					% Pop. 25+ with B.A. or Higher				
	1970	1980	1990	2000	2005-2009	1970	1980	1990	2000	2005-2009
North Kona	28.6	28.4	34.7	39.4	40.3	8.8%	18.8%	20.5%	24.7%	27.5%
South Kohala	28.1	28.9	32.1	36.2	36.7	13.1%	20.7%	26.2%	27.4%	31.1%
South Kona	29.7	29.1	34.6	41.2	45.1	6.3%	12.5%	20.3%	22.5%	24.8%
Total W. Hawai'i	N/A	N/A	N/A	N/A	N/A	8.8%	17.7%	21.8%	25.0%	28.1%
Rest of County	N/A	N/A	N/A	N/A	N/A	8.8%	14.3%	16.9%	20.6%	25.1%
County of Hawai'i	25.0	29.2	34.3	38.6	39.4	8.8%	15.2%	18.5%	22.1%	26.2%

Source: U.S. Census Bureau, Summary File 1, 1970, 1980, 1990, 2000; American Community Survey, 2005-09 averaged data

As the population has aged, the percentage of all households consisting of families has declined (from 74% islandwide and 72% in West Hawai'i as of 1990, to 70% both islandwide and in West Hawai'i as of 2000, and to about 68.5% both islandwide and in West Hawai'i as of the 2005-09 ACS). The percentage of all families with children is dropping, and the percentage of children in single-parent households is rising. As of the 2005-09 ACS, family structure was roughly the same in West Hawai'i as the rest of the county, though South Kohala was notable for having fewer families with children (Figure 2.8).

Figure 2.8 Family Structure, West Hawai'i and County, 2005-09 Average



2.3.3 Other Social Characteristics

The 2000 Census found about 10% of the population (both in West Hawai'i and the rest of the county) was foreign-born. Roughly one-fourth of the households in both parts of the island spoke a non-English language at home – primarily Asian and Pacific languages (e.g., Hawaiian or Filipino dialects) rather than Spanish (spoken by just 3.4% of West Hawai'i households, despite widespread awareness of scattered Mexican in-migrants in recent years).

Additionally, the University of Hawai'i's Center on the Family (COF) prepared a summary of social and educational indicators available in the early 2000s for various communities as defined by public high schools covering those areas. Table 2.4 gives descriptions of three areas roughly comparable to "West Hawai'i" as discussed in this report:

Table 2.4 Summary of Social and Educational Community Indicators

North Kona (Keālakehe School Complex)	South Kohala and Hāmākua (Honoka'a School Complex)	South Kona (Kona Waena School Complex)
This community has one of the lowest proportions of unemployed in the State, and the per capita income is just above the State average. Residential stability, however, is lower than in most communities, with fewer than half of the people who live in the North Kona Area having been born in the islands. The child abuse rate is double the State average and the percentage of "idle teens" (not in school and not working) is higher than in most of the communities Statewide. In a Statewide survey of 6th, 8th, 10th, and 12th graders, more than half of the adolescents responding in the North Kona Area reported a lack of interest in school, which is evident in a graduation rate that is lower than in most communities. Despite these problems, the data for other indicators of child and family well being in this area are more positive. The North Kona Area ranks in the upper third of communities for adults who hold a high school diploma or a college degree. The community has the third-highest number of public school teachers with advanced degrees. In addition, more than half of the adolescents responding to the student survey reported close family ties.	There are a number of challenges for children in the Honoka'a Area. It ranks in the lowest third for school safety (as reported by teachers, parents, and students). The percentage of 3rd graders with low SAT reading scores is higher than the State average. In a Statewide student survey, about one-half of the adolescents responding in this community reported poor parental supervision as well as a lack of interest in school. Only about two-thirds of the high school seniors in 2002 planned to attend college, a percent that is lower than the State average. However, about two-thirds of those students were accepted, a result that is above the State average. ...While Hawai'i County as a whole has a higher percentage of children living in poverty than the rest of the State, in the Honoka'a Area the child poverty rate is lower than the State average. The proportion of the population relying on the Food Stamp and Temporary Assistance to Needy Families (TANF) programs is less than elsewhere in the State and much less than Hawai'i County. Almost 60% of the adolescents responding to the student survey reported close family ties.	Although unemployment is low, the per capita income in the South Kona Area is lower than the State as a whole. The poverty rate for children under age 5 is high, and the child abuse rate is double the State average. Residential stability—the percentage of people living in the same home for more than 5 years—is higher than the County and State levels. However, teachers here rank last in the State for longevity in their current school setting, and the percentage of graduating public school seniors is one of the worst in the State. The data for other indicators of child and family well being in the South Kona Area are more positive. Most adults have a high school diploma and the percentage with a college degree is higher than the County level. The 3rd graders do slightly better on the SAT reading test than the State as a whole. Teachers in this community report one of the highest percentages of school safety, and 8th graders' reports of feeling safe at school are the best in the State. More than half of the adolescents from this area who responded to a Statewide survey of 6th, 8th, 10th, and 12th graders reported adequate parental supervision and close neighborhood and family ties.

Source: University of Hawai'i Center on the Family, http://uhfamily.Hawai'i.edu/cof_data/profiles/profiles.asp
Note: Child abuse rates mentioned here based on just one year, and these rates can fluctuate greatly.

The COF's organization of Census data by school area also indicated the West Hawai'i regions had particularly high percentages of children aged 0-5 with both parents in the workforce. North Kona was the highest, with more than 70% of young children in this situation. The county average was 63%.

2.4 Business Characteristics and Tourism

2.4.1 Overview of Private-Sector Economic Activity

While tourism and related growth has been a driving force, other economic activity also serves the population. Figure 2.9 and Figure 2.10, as well as Table 2.5, on the following pages are all based on U.S. Census "County Business Patterns" data, which provide both county-level and ZIP code information from 1994 for number/type of business establishments, number of employees, and total business payroll. Note that government jobs are not included here.

The most recent available data are from 2008, thus capturing the onset of the Great Recession. As a result of that recession, visitor arrivals fell across the state, and there were reverses in employment, payroll, and numbers of business establishments. However, the figures also show longer-term trends from 1994.

The figures (as well as some Census data not directly show in the figures) indicate:

- Hawai'i Island's economic growth from 1994 to 2008 took place almost entirely in West Hawai'i – 79% job growth in the six West Hawai'i ZIP code areas vs. 16% in the rest of the island. In 1994, 42% of the island's private-sector jobs were in West Hawai'i, including 21% in Kailua; as of 2008, these figures were 53% and 31% respectively. (However, Hilo remains the core for government.)
- The Kailua-Kona ZIP code area (which includes the project site) accounted for 60% of all West Hawai'i businesses and 55% of all West Hawai'i jobs in 2006. The Kailua growth rate has been a little greater than average for the rest of West Hawai'i.
- Overall, the Kamuela area is currently the second most important economic center in West Hawai'i, though the Waikoloa area has been growing very rapidly. In terms of percentage growth in jobs, Kamuela and Kealakekua have been growing least rapidly. The job growth rate for Hōlualoa has been particularly high since 2002.[11]
- Since 1994, adjusted for inflation, payroll per private-sector employee increased by 26% in West Hawai'i (vs. 15% in the rest of the island) and by 29% in the Kailua ZIP area. This includes some declines in payroll from 2006 to 2008.
- Employment has been growing more rapidly than the number of businesses islandwide, particularly in West Hawai'i. This suggests a structural transformation in the economy – more large business and/or expansion of existing businesses, rather than addition of many small new ones. Socially, more West Hawai'i workers are now employed by medium- or large-sized establishments, suggesting more benefits but less intensive social interactions with co-workers.

[11] A note of caution: County Business Pattern estimates are based in part on actual data, in part on economic modeling, and the modeling effects can particularly impact numbers for less populated areas such as Hōlualoa. Figures are considered best for years ending in "2" or "7," when the Economic Census is done and provides more direct data.

Figure 2.9 Growth in Business Establishments, 1994 – 2008

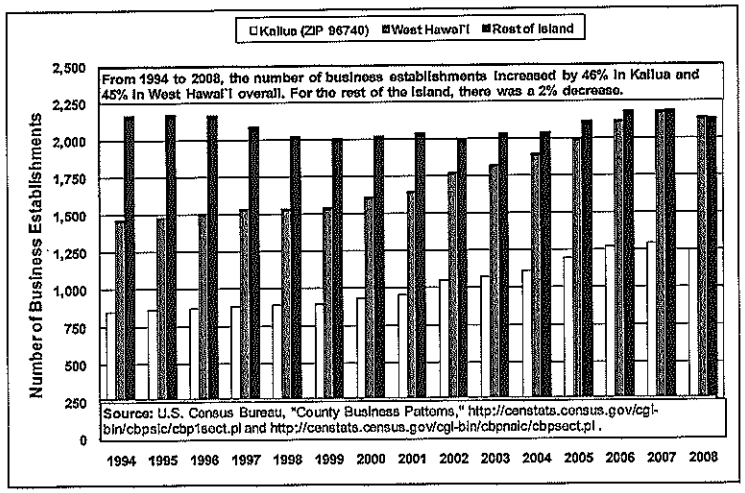


Figure 2.10 Growth in Employees and Total Annual Payroll, 1994 – 2008

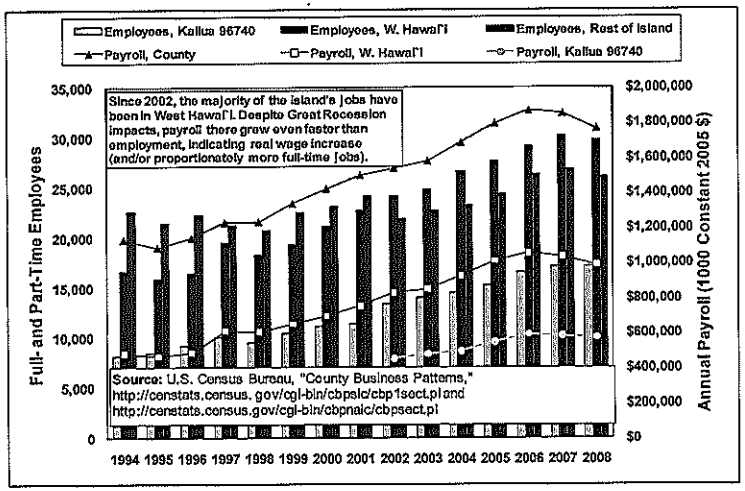


Table 2.5 Business Activity Differences by Geographical Areas

	2008 West Hawai'i Distributions and Data				Total Percentage Change, 1994-2008			
	% of West Hawai'i Total		Averages					
	No. of Businesses	No. of Full- or Part-Time Workers	Workers Per Business	Payroll Per Worker[a]	No. of Businesses	No. of Full- or Part-Time Workers	Workers Per Business	Payroll Per Worker[a]
Kamuela 96743	21%	29%	14.6	$36,963	32%	5%	-21%	21%
Waikoloa 96738	7%	7%	19.4	$40,823	274%	1112%	224%	22%
Kailua 96740	***60%***	***55%***	***13.7***	***$35,691***	***46%***	***110%***	***44%***	***29%***
Hōlualoa 96725[b]	2%	1%	4.2	$29,789	85%	107%	12%	52%
Kealakekua 96750	7%	5%	12.3	$39,425	7%	39%	30%	39%
Hōnaunau 96704[b]	3%	3%	11.1	$31,451	2%	125%	121%	13%
Total West Hawai'i	100%	100%	13.9	$33,203	45%	79%	23%	15%
Total, Rest of Island	(NA)	(NA)	12.3	$29,870	-2%	16%	18%	3%

[a] In constant 2008 dollars.

[b] Small areas (in terms of economic activity) like Holualoa and Honaunau naturally vary more over time. Thus, percentage changes could also differ more, depending on the years selected.

2.4.2 Volatility in Tourism

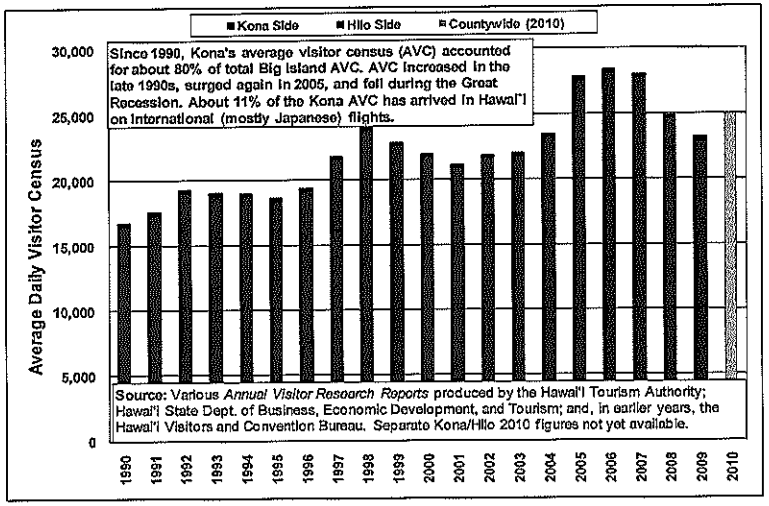
Tourism, West Hawai'i's primary industry, has a recent history of volatility. Figure 2.11on the following page shows that, since 1990, the average daily visitor census (AVC) for Kona and Hawai'i Island generally grew through 1998; dipped for a few years thereafter; surged strongly from 2001- 2006, when Hawai'i became increasingly recognized as a safe tropical destination for Americans afraid of traveling abroad; and fell sharply during the Great Recession. Kona-specific numbers are not yet available, but countywide trends were again upwards for the first part of 2010.

However, Kona tourism may suffer some further setbacks from Japan Airlines' (JAL's) decision to end direct service to Kona from Narita at the end of October 2010. This was the only flight from Japan to Hawai'i Island, and recovery in international arrivals had been the strongest component of the island's rebounding tourism numbers through August 2010. In the previous few years, Kona and the rest of the state's tourism industry were affected by the demise of Aloha Airlines and reduced cruise ship service.

On a more hopeful economic note, through August of 2010, Kona had gained about 16% additional scheduled domestic airplane seats over the previous year to date figure, which was the largest gain of any Hawai'i airport.[12] And the late 2010 addition of nonstop service from the Northwest to Kona could help soften the impact of the JAL withdrawal.

[12] State of Hawai'i Department of Business Economic Development and Tourism. Various Monthly Visitor Statistics reports.

Figure 2.11 Kona and Hawai'i Island Average Visitor Census, 1990 – August 2010



Some recovery in Hawai'i Island's (and likely Kona's) visitor industry is apparent for 2010 in terms of visitor counts, though hotels were offering discounts in order to attract visitors who were spending less as the economy continued its slow national recovery.

2.4.3 Economic Forecasts for Future

Recent economic cooling on Hawai'i Island is expected to continue through at least 2009.[13] The visitor industry faces major headwinds as does Hawai'i Island's agriculture industry.[14] The construction industry is also in decline.[15] Some Hawai'i Island industries are doing well – the Natural Energy Laboratory of Hawai'i Authority for example, is well positioned to prosper as a producer of boutique drinking water in an otherwise dreary current economic environment.

The 2005 *County of Hawai'i General Plan* – prepared by the Hawai'i County Planning Department – contains a series of three different islandwide forecasts for visitor units

[13] University of Hawai'i Economic Research Organization. County Economic Forecast, May, 2008.

[14] Honolulu Star Bulletin. *Wilting Slowly*, May 11, 2008. http://starbulletin.com/2008/05/11/news/story08.html.

[15] First Hawaiian Bank Economic Forecast for Hawai'i County, *"Hawai'i County's Growth Muted"*. Analysis by Leroy Laney. http://www.fhb.com/pdf/EconForecastBigIsland07.pdf.

and for "total visitors" (total annual count, not average daily census), though these forecasts were actually prepared in 2000 and extend only to the year 2020. All three forecasts are for about the same number of visitor units (about 11,450), though the projected number of visitors ranges from 1.5 million to 2.3 million (vs. a little under 1.3 million in 2000). The *General Plan* explicitly assumes the possibility of somewhat more growth outside the visitor industry than does the DBEDT forecast. But several of the non-tourism factors mentioned in the plan – such as a Hilo Call Center and a new State prison – now appear less likely to occur.

2.5 Workforce, Labor Supply, and Income

2.5.1 Civilian Labor Force, Unemployment, and Labor Supply

The Civilian Labor Force (CLF) consists of all prospective workers, employed or unemployed. The Hawai'i State Department of Labor and Industrial Relations (DLIR) provides estimates CLF only at county-wide levels, but the decennial Census does have figures for County Census Divisions (such as North Kona) for years ending in "0,"[16] as well as the averaged 2005-09 ACS numbers.

Table 2.6 shows Census figures since 1970. Note that, as of 2000, only about 38% of the CLF lived in West Hawai'i, though the preceding Figure 2.10 indicated close to 50% of the private-sector jobs were then located in West Hawai'i (and the figure rose to more than 50% in subsequent years). This indicates that commuting into West Hawai'i for employment is clearly higher than commuting out.

Note also that the average annual rate of growth in labor force has been consistently larger for West Hawai'i than for the rest of the county. In general, the growth rate was declining over time to 2000, but then rose (particularly in North Kona and South Kohala) in the boom of the 2000s prior to the Great Recession. Because the percentage applies to a larger base figure, this means the absolute average growth in workforce for the early 2000s has actually been larger than that experienced in the 1990s, in terms of absolute numbers

[16] Census and DLIR figures differ somewhat for years ending in "0," because the Census count is for April 1 and the DLIR estimate is for the year's average.

Table 2.6 Countywide and West Hawai'i Civilian Labor Force, 1970 – 2009

Total Civilian Labor Force	1970	1980	1990	2000	2005-09
North Kona	2,022	7,292	11,898	15,848	21,063
South Kohala	951	2,110	4,882	6,862	9,357
South Kona	1,535	2,823	4,029	4,467	4,796
Total West Hawai'i	4,508	12,225	20,809	26,813	35,216
Rest of County	21,381	28,781	36,177	43,779	53,246
County of Hawai'i	25,889	41,006	56,986	70,592	88,462

Average Annual Percentage Increase	1970-1980	1980-1990	1990-2000	2000 to 2005-09
North Kona	13.7%	5.0%	2.7%	4.1%
South Kohala	8.3%	8.8%	3.5%	4.5%
South Kona	6.3%	3.6%	1.0%	1.0%
Total West Hawai'i	10.5%	5.5%	2.6%	4.0%
Rest of County	3.0%	2.3%	1.9%	2.8%
County of Hawai'i	4.7%	3.3%	2.2%	3.3%

Source: U.S. Census Bureau, Decennial Census for 1970-2000; Census Bureau American Community Survey for averaged 2005-09 data. For estimating percentage increase from 2000, a seven-year period was assumed.

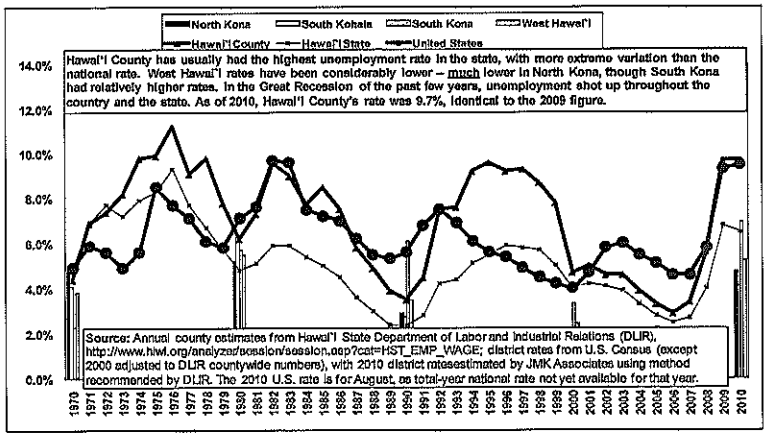
A key social characteristic of Hawai'i Island's workforce has been its high female civilian labor force participation rate (CLFPR – the percentage of the population aged 16+ actually in the CLF). Both male and female CLFPR have been much higher in West Hawai'i than the rest of the county, with no appreciable female differences between North Kona, South Kohala, and North Kona but higher male rates in South Kohala and lower in South Kona (Table 2.7).

Table 2.7 Civilian Labor Force Participation Rates (CLFPR), 2000 and 2005-09

	Hawai'i County	Rest of County	West Hawai'i	North Kona	South Kohala	South Kona
2000 Census						
Male CLFPR	64.7%	60.0%	73.7%	73.2%	76.3%	71.7%
Female CLFPR	58.7%	55.7%	64.7%	65.1%	65.2%	62.6%
2005-09 ACS						
Male CLFPR	68.6%	64.7%	75.4%	74.7%	81.4%	68.0%
Female CLFPR	60.9%	58.0%	66.0%	65.9%	65.1%	67.9%

Compared to other Hawai'i counties, Hawai'i Island has generally had a high unemployment rate, but current estimates indicate an atypically low one. Note, however, the great swings that have characterized the island's economic cycles over time, and the absence or delay of the historically "normal" increase in unemployment that might have seemed expectable for the first part of the last decade:

Figure 2.12 Unemployment Rates – U.S., County, and West Hawai'i, 1970 – 2010



Hawai'i County's 2009 unemployment rate was 9.7%, and was unchanged in 2010. Much of the preceding 2005-07 low unemployment had to do with a construction boom that has now become a construction bust. Though no recent Kona-specific data are available, it is likely that the unemployment rate there remains lower than the rest of the county, as it has in the past (Table 2.7).

2.5.2 Employment by Industry

As might be expected, Census data show residents of West Hawai'i were much more likely than those of East Hawai'i to be in the "Accommodation and Food Services" sector, less likely to work in Public Administration or Education. This was particularly true in South Kohala, while the South Kona pattern was more like that of East Hawai'i.

(Note: The averaged 2005-09 figures in Table 2.8 were little changed from the comparable percentages that could be calculated from the 2000 Census.)

Table 2.8 Distribution of Resident Workers by Industry, 2005-09 Average

	Hawai'i County	Rest of County	West Hawai'i	North Kona	South Kohala	South Kona
Agriculture, forestry, fishing and hunting, and mining	4.3%	4.5%	3.9%	2.4%	4.0%	9.6%
Construction	11.4%	10.6%	12.7%	12.6%	12.1%	14.5%
Manufacturing	2.8%	2.8%	2.9%	2.7%	3.4%	3.0%
Wholesale trade	2.7%	3.6%	1.4%	1.6%	0.8%	1.6%
Retail trade	12.8%	12.3%	13.4%	15.5%	9.4%	12.2%
Transportation and warehousing, and utilities:	4.1%	4.1%	4.2%	4.5%	4.3%	2.5%
Information	1.3%	1.3%	1.1%	1.3%	1.0%	0.7%
Finance, insurance, real estate and rental and leasing	6.1%	5.0%	7.6%	8.8%	5.7%	6.0%
Professional, scientific, management, administrative, and waste management services:	8.6%	7.2%	10.7%	11.3%	10.1%	9.8%
Educational services	9.9%	12.6%	6.0%	4.8%	7.6%	7.9%
Health care and social assistance	8.6%	10.5%	5.8%	6.1%	3.2%	9.7%
Arts, entertainment, and recreation	3.0%	2.9%	3.0%	2.8%	3.9%	2.0%
Accommodation and food services	14.7%	11.1%	20.0%	18.8%	28.2%	9.1%
Other services (except public administration)	4.5%	4.4%	4.7%	4.8%	4.2%	5.0%
Public administration	5.3%	7.0%	2.7%	2.0%	2.1%	6.5%

Source: American Community Survey, 2005-09 averaged figures.

(Green shading indicates relatively high numbers, and yellow, relatively low ones.)

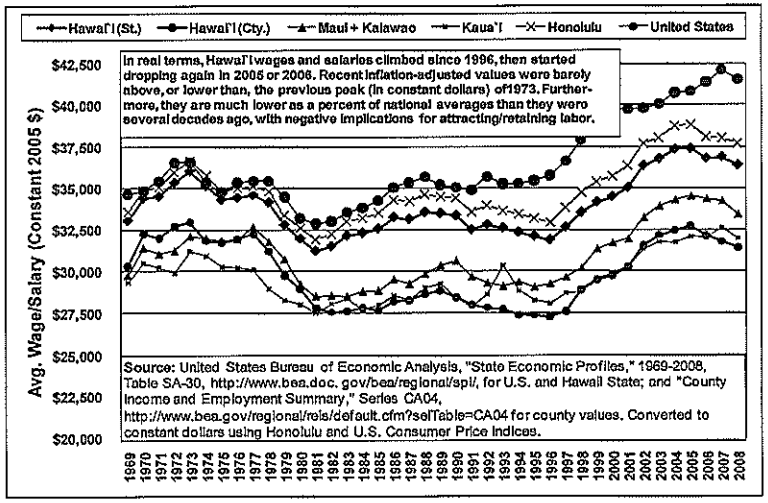
2.5.3 Wages and Income

Annual data about average individual wage and salary (as compared to aggregate measures such as "household income") comes from the U.S. Bureau of Economic Analysis, though it is for the county as a whole and not for individual areas such as West Hawai'i. Figure 2.13 on the following page shows that inflation-adjusted wages declined nationally and throughout Hawai'i as the country moved from an industrial to more of a service-based economy, hit a low point around 1980, then started rising again since 1996. However, housing-driven inflation slammed on the economic brakes and drove real earnings back down around 2005 or 2006. Furthermore, Hawai'i as a whole – and Kaua'i and Hawai'i Island in particular – have greatly and consistently lagged national averages for many years.

Within Hawai'i Island, a variety of indicators from the 2000 Census suggest higher incomes in the West Hawai'i study area than for the rest of the island. Both poverty and public assistance rates for the combined three West Hawai'i districts were about half that for the rest of the county. And aggregate median incomes were higher in 2000:

	Countywide	N. Kona	S. Kohala	S. Kona
Median family income:	$46,480	$51,525	$56,905	$48,989
Median household income:	$39,805	$47,610	$51,379	$42,058

Figure 2.13 Average Wage & Salary, 1969 – 2008, U.S. Vs. Hawai'i and Counties



Aggregate measures such as family and household income can represent incomes from different numbers of household workers for different times and places. Table 2.9 on the following page shows that:

- Inflation-adjusted household income, especially at the county and North Kona levels, remained essentially stagnant from 1980 to 2000, then apparently increased somewhat in the later 2000s (though the ACS 2005-09 figures average income reported during both an economic boom and also the following Great Recession).
- However, the number of workers per household – perhaps contrary to general impressions, but in line with the aging of the population – actually decreased rather than increased in the same timeframe. (The number edged back up again in the late 2000s, though the averaged five-year timeframe makes that difficult to interpret.)
- Thus, at least through 2000, fewer workers per household were needed to bring in roughly the same household income, and so the "average" real wage – consistent with Figure 2.13 above – increased (particularly in West Hawai'i).

Income data are multi-faceted and complex. Other data could demonstrate that income inequality increased during the same period, and it is not certain that average or median increases were equally enjoyed by all segments of the society. Also, the economic changes since 2000 may have altered this picture. (As noted below, the Great Recession in the last few years appears to have driven down per-worker incomes.) But

the long-term picture is one of increasing real income since Hawai'i's low point of 1980, and more so for West Hawai'i than for the rest of the county.

Table 2.9 Effect of Changing Number of Household Workers on Income

	1980	1990	2000	2005-09
A. Median Household Income (2009 Dollars) for Preceding Year				
County of Hawai'i	$52,558	$53,109	$52,839	$55,645
North Kona	$60,648	$63,212	$63,200	$64,802
South Kohala	$54,948	$71,243	$68,203	$75,912
South Kona	$50,159	$55,934	$55,830	$58,849
B. Employed Civilian Labor Force Per Household				
County of Hawai'i	1.30	1.31	1.23	1.31
North Kona	1.50	1.46	1.41	1.41
South Kohala	1.33	1.53	1.43	1.51
South Kona	1.44	1.46	1.35	1.41
C. Median Household Income Divided by Employed Civilian Labor Force Per Household (A divided by B), 2009 Dollars				
County of Hawai'i	$40,279	$40,516	$43,086	$42,394
North Kona	$40,374	$43,218	$44,669	$46,122
South Kohala	$41,197	$46,450	$47,786	$50,272
South Kona	$34,915	$38,299	$41,243	$41,717

Source: U.S. Census Bureau, 1980 - 2000 Summary File 3; American Community Survey 2005-09 averaged data. Divisions and inflation adjustments (using Honolulu Consumer Price Index) by John M. Knox & Associates, Inc.

2.5.4 Employment Forecasts

The previously mentioned DBEDT forecasts anticipate roughly 96,000 people employed islandwide in 2020 and 124,000 in 2035 (up from 69,000 in 2005 – roughly an 80% increase from 2005 to 2035). Based on trends over the past decades, it may be assumed that most of these additional jobs will be *located* in West Hawai'i, though housing issues make it less certain that the additional workers will *live* there.

The *County of Hawai'i General Plan*'s three different forecast series for 2020 range from 103,500 to 117,500 jobs (which is different from "people employed" due to factors such as multiple job-holding, part-time vs. full-time employment, etc.).

From a 2005 base of 69,000 jobs, the County's projection for job growth is greater than the State's, County numbers equate to anywhere from 50% growth (for Series A) to 70% growth (for Series C) in just 20 years while the State projects just under 40%. However, the County document remains silent on the geographical distribution of the projected heavy job growth.

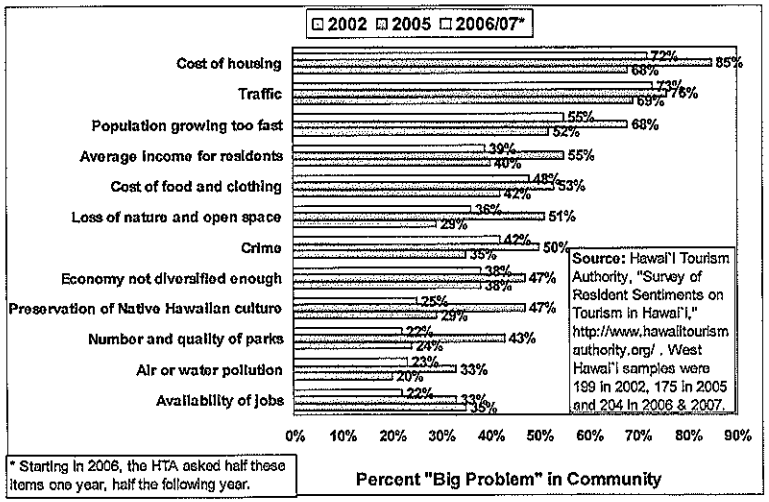
2.6 General Community Issues and Attitudes

In addition to stakeholder interviews described in following sections, we here examine opinion survey evidence related to community issues.

In 2002, 2005, and a split 2006-07 survey, the Hawai'i Tourism Authority (HTA) included small "West Hawai'i"[17] samples in its statewide "Survey of Resident Sentiments on Tourism in Hawai'i." The survey began with a list of potential community problems – with no specified links to tourism.

Figure 2.14 indicates that *cost of housing* and *traffic* were the critical issues as of 2006-07, followed by *population growing too fast*. The figure also indicates that *availability of jobs* was the least important of the listed issues and that even its perceived importance had dropped off by 2006.

Figure 2.14 West Hawai'i Resident Perceptions of Major Community Problems



[17] "West Hawai'i" for this survey included a somewhat larger area than otherwise used for the current report – "Pa'auilo through the Kohalas, Konas, and Ka'ū." It should also be noted that the list of community issues for the survey was restricted to particular concerns often associated with tourism. One issue of more general concern in rural Hawai'i – substance abuse – was not included on the list.

Note: The HTA did another resident survey in 2009, but did not break out West Hawai'i results.

3. COMMUNITY ISSUES AND PERCEIVED IMPACTS

This section focuses on results of community interviews. It covers the following topics:

- Purpose and methods;
- "Background" issues and concerns (context for project);
- General project – awareness and overall issues;
- Specific project elements – issues and concerns; and
- Perspective of adjacent National Historical Park.

3.1 Purpose and Methods

Purpose: Social impacts involve values and perceptions. They also involve many concerns that cannot be "objectively" determined with certainty, because cause-effect relationships are not always easy to determine. Over the several decades that we have been doing this sort of work in Hawai'i, we have talked to social agency representatives who believe that social problems are due largely to rapid economic development... and to others who believe the exact same problems are due to lack of economic development. Both may be right. The point is that "experts" cannot always draw a clear and accurate conclusion. In the long run, social impacts may have to do not only with *whether* a project occurs, but with *how* it is carried out.

Therefore, an important part of social impact assessment involves interviewing knowledgeable community leaders and observers – "stakeholders" from a wide spectrum of beliefs and interests. The results are not like the survey percentages reported at the end of the foregoing section, because interviewees were deliberately rather than randomly selected. There is therefore no way to know if the opinions expressed by our interviewees are representative of the population or not.

However, the community interview method complements survey results by:

(1) Allowing for a much more in-depth discussion; and

(2) Focusing on specifically affected groups – such as nearby residents, business owners, or local political leaders – who could be greatly under-represented in a typical telephone survey.

Ultimately, the purpose of these interviews is to disclose social issues and concerns. (The term "social" is used broadly here, since many interviewees find it difficult and irrelevant to make fine distinctions among social, environmental, economic, and other issues.) When possible, we will also make analytic comments and offer suggestions for mitigations and enhancements.

Methods: A total of 24 interviews (with 29 individuals as some interview sessions comprised of more than one interviewee) were conducted for this Social Impact Assessment. All interviews were conducted from November 2010 through March 2011, by face-to-face meetings (the majority), and via telephone. Interviewees were assured that:

- All discussions were confidential – we would list names but not quote anyone by name.
- Information about community affiliations would be reproduced only to show the range of interests represented and why these people were selected. ***No interviewee was speaking on behalf of any organization listed in Table 3.1.***

Although discussions could be free-flowing and did not necessarily follow a script, we developed an interview guide (Appendix A) along with a then-current Project Description (Appendix B) that contained three broad types of questions:

1. Background issues affecting West Hawai'i, independent of the project;
2. Overall issues specific to the project; and
3. Specific issues related to project elements, focusing on these main project components: hospital; adherence to the Kona Community Development Plan; project phasing; residential component; roads and infrastructure; commercial, retail and high tech elements; schools; and trails, park space and open area.

Table 3.1 List of Community Interviewees

Name	Title, Affiliation
Kathy Billings*	Park Superintendent, Kaloko-Honokōhau and Pu'uhonua O Honaunau National Historical Parks, National Park Service
Aric Arakaki	Superintendent, Ala Kahakai National Historic Trail, National Park Service
Sallie Beavers	NPS Marine Ecologist and Chief of Resources, National Park Service
Rick Gmirkin	Community Archaeologist, Ala Kahakai National Historic Trail, National Park Service
Fred Keakaokalani Cachola	President, Makani Hou; Chairman Nā Kōkua
Denny Coffman	Representative, House of Representatives, 6th District
Laura Dierenfield	Executive Director, People's Advocacy for Trails Hawai'i (PATH)
Bob Ward	Board Vice President, People's Advocacy for Trails Hawai'i (PATH); Member, Kona CDP Action Committee
Fritz Harris Glade	Member, Kona CDP Action Committee; Former Vice Chair, Kailua Village Design Commission; Board Member, Kailua Village Business Improvement District
Glennon Gingo	Agent/Broker, Hawai'i & Pacific Commercial Properties; Director of Manta Pacific Research Foundation
Kelly Greenwell	Hawai'i County Council District 8
Marni Herkes	Vice President of Public Affairs, Kona Outdoor Circle
Jacqui Hoover	Executive Director and CEO, Hawai'i Island Economic Development Board; President, Hawai'i Leeward Planning Conference

Name	Title, Affiliation
Paul Horner	General Manager, Keauhou Beach Hotel
Bo Kahui	Executive Director, La'i'opua 2020
Irving Kawashima*	Section Manager, Hawai'i Nā Ala Hele, Department of Land and Natural Resources
Clement Chang	Access Specialist, Hawai'i Nā Ala Hele, Department of Land and Natural Resources
Vivian Landrum	President, CEO, Kona Kohala Chamber of Commerce
Gretchen Lawson	Member, Kona CDP Steering Committee; President and CEO, The Arc of Kona
Elizabeth Lee	Kona Community lineal descendant, Kūpuna
Reggie Lee	Hui O Na Kūpuna
Susan Maddox	Interim Executive Director, Kona Neighborhood Place; Executive Director, Friends of the Future
Ken Melrose	Chairman, Kona CDP Action Committee; Senior Project Manager, Pa'ahana Enterprises LLC.
Ken Obenski	Acting Chair, Kona Traffic Safety Committee
Rob Pacheco	CEO, Hawai'i Forest and Trails; Board Member, Board of Land & Natural Resources; Board, Hawai'i Island Visitors Bureau; President TREE Hawai'i
Aaron Stene	The Kona Blog
Phil Tinguely	President, Tinguely Development, Inc.
Curtis Tyler	Property Manager, Small Business Owner; Former Councilman
Rodney Watanabe	Executive Vice President, Member Services, Hawai'i Community Federal Credit Union

* Note: These interviews were conducted as a group, with person(s) whose name(s) is/are italicized below.

Although we have done West Hawai'i community interviews only occasionally over time, we have noted increased difficulty in getting participation there – either non-responses or refusals – particularly on the part of environmentally-oriented interest groups. Among those who declined, a common theme was ***suspicion of developer representatives*** (in general, not Stanford Carr in particular) and concern that any comments they made would be ignored and/or misrepresented as indicating some type of endorsement. Here are some examples from people who asked that their names not be included:

Mahalo for the email. As a rule, I don't take part in developers' interviews, as it has lead to nothing but misrepresentation by those community members and groups who have taken part in them. Unfortunately, it seems that these types of interviews are used to make a project look good, rather than truly improve the project.	*If Stanford Carr presents an environmentally- and culturally-sensitive KCDP-conforming project (not just according to what the current County administration calls "conforming" but truly so), they'll have a better chance of a glitch-free permitting process. If the project abuses the land, the laws, or the Kona community, it won't be so easy.*	*My experience in meeting with developer representatives is that my concerns are not properly addressed even while I'm listed as having been consulted. I will submit written comments once you have issued your EISPN.*

3.2 Background Community Issues and Concerns

Most of our interviews began with general questions intended to shed light on values and background issues, independent of the project – both positive aspects and problematic issues about West Hawai'i in general. The themes outlines in Table 3.2 represent issues and concerns most frequently mentioned during our interviews.

Table 3.2 Current Issues on People's Minds about Kona in General

Current Issues and Concerns
Health Care and Education Issues
Lack of good health care, facilities, and caregivers
Lack of education opportunities for local residents
Current Economic Issues
Lack of jobs and good paying jobs, and imbalance between where jobs are located and the location of housing for the workforce
High cost of living
Economic vitality: dependence on imports, lack of new money coming in, need sustainable economic growth, not only short term
Ranching and cattle raising facing strong challenges
Community and Effects of Rapid Growth Issues
Managing growth: sustainability vs. growth conflict, speed of development
Influx of outsiders who may not understand local lifestyle promoting "land for profit" as opposed to "land for living"
Crime and drugs
Housing Issues
Not enough affordable housing
Access and Infrastructure Issues
Harbor is old, county infrastructure is aging (sewer specifically)
Queen Ka'ahumanu Highway widening issues: access
Traffic
Political Issues
Perverse incentive: Hilo benefits from tax revenues generated by developments in Kona, but Kona suffers from the resulting traffic and socio-economic impacts
Inefficient planning: Projects approved out of Hilo, no infrastructure to support projects, no following through on conditions
Too many land use conversions (conservation and agricultural to urban land uses)
Lack of good political leadership
Population growth: demographics incoming vs. demographics being planned for
Polarization in planning issues
Environmental Issues
Vog and threat of volcanic activity – worries about permanent impacts on quality of life, housing value
Increasing negative impacts to the natural environment, coastal areas and cultural resources
Lack of open space

Health Care and Education Issues: Interviewees often mentioned concerns about health care and education in Kona – including lack of access to medical facilities, reportedly leading to people having to be evacuated to Honolulu for treatment, insufficient staff, lack of good doctors, nurses and health care specialists, and inadequate facilities. A few people said the hospital has been having funding problems, which has made it difficult to keep doctors, specialists and nurses in Kona.

Current Economic Issues: The entire nation has been having difficult economic times, and Kona is not immune. Issues associated with the impacts of the national economic crisis include a lack of new money coming in, local businesses suffering (even affecting the success of longtime industries ranching and cattle raising), higher cost of living, lack of local jobs (and good paying jobs), and lack of adequate housing for workers, especially low-income ones. Residents also reported a perceived imbalance between where jobs are located and the location of "affordable" housing for the local workforce.

Community and Effects of Rapid Growth Issues: Interviewees expressed concern about the rapid growth occurring in Kona, and the difficulties associated with managing this growth. The speed of development, as well as population growth, were both viewed with apprehension. The ongoing influx of people and rapid development were seen as leading to cultural, social, and environmental problems. Some people said newer resident may not understand local lifestyle and have more of a "land for profit" as opposed to "land for living" mentality. Increased crime and drug use were also reported as concerns attributed to rapid growth (though it should be noted that we also often encounter the same issues in rural areas with stagnant economies).

Housing Issues: Lack of housing options for the local workforce is a great concern for the people in Kona. Interviewees, on the whole, all said they concurred that there is just not enough affordable housing options for the Kona workforce, and that what is being planned in the region often does not seem to meet that demand, but rather caters to off-islanders – vacation and/or retirement homes for the affluent.

Access and Infrastructure Issues: According to interviewees, access and infrastructure issues are a significant concern in Kona. Interviewees remarked that the Kona Harbor is old, that county infrastructure is aging (sewers specifically), and that access and traffic are an escalating issue in Kona. There have also been many problems with the Queen Ka'ahumanu Highway widening project.

Political Issues: A decades-old issue involves the fact that West Hawai'i is the County's prime source of growth in tax revenues, but planning and infrastructure decisions are made in the East Hawai'i county seat (Hilo). Interviewees said they perceived a perverse incentive in the fact that Hilo benefits from developments in Kona, but Kona suffers from the resulting traffic and socio-economic impacts of these approvals. They saw this as inefficient planning, as planning projects are approved with no adequate infrastructure to support projects, from a remote place that won't feel the consequences of failing to plan properly.

Lack of good political leadership was also seen as the root cause for perceived frequent conversion of land uses (conservation and agricultural to urban land uses), and developments being allowed to move forward, with no follow-through on conditions.

Environmental Issues: Although vog and volcanic activities were of some concern to interviewees, threats *to* the environment – as opposed to threats *from* the environment – was at the forefront to of interviewee concerns. People said they were seriously concerned about increasing negative impacts to the local natural environment, coastal areas and cultural resources due to development and population growth.

3.3 Overall Project – Awareness and General Issues

3.3.1 Level of Awareness of Project

Interviewees were asked whether or not they had heard about the Kaloko Makai proposal prior to our contacting them, as well as their perceptions as to whether this project was well known in the community.

Interviewees, on the whole, seemed to be aware of the proposed Project at Kaloko Makai, though they were not always aware of all details. Since this Project has been "in the works" for quite some time, it did not come as a surprise to most interviewees – who, as community leaders, tend to track development proposals more closely. However, most interviewees said they thought the project is ***not yet well known to the majority of Kona residents.***

> *"There's awareness, but I don't think people understand scope of it."*

> *"No doubt, the project is known to county and land-use planners, but probably less known by the general public."*

3.3.2 Image of Developer

We also inquired about whether the Stanford Carr Development company is well known in the Kona community, and if it has a particular image (positive, negative or neutral). ***Most interviewees reported a neutral to positive image*** – focused more on Mr. Carr himself than on the company as a whole – although a few people mentioned concerns over the suspended work at Kaloko Heights and reported unresolved business issues with a local contractor.

Especially because Kaloko Heights and other area developments have come to a stop, there was also some degree of surprise as to the developer's confidence about proposing such a large development in this economy.

> *"What concerns me is the fact that they are wanting to get this huge project started. So many projects have been stalled since the recession and are not completed from the recession of the early 90's. Lots of completed places have not even sold yet."*

There was also some sense that ***Stanford Carr, as a "local" (Hawai'i-born) developer, could be perceived more favorably than other developers.*** For some, this increased expectations for the Kaloko Makai project.

> *"Stanford Carr is uniquely positioned to set the bar for Kona in terms of livability, because a project of this magnitude would draw lots of attention."*

3.3.3 Issues about the Project in General

Interviewees were asked what they saw as both the most positive and also the most problematic things about the Kaloko Makai Project. Interviewees were excited, or at least cautiously optimistic, about many of the proposal's specific components. ***Most interviewees spoke to possible changes to the current proposal, instead of discounting or rejecting the entire plan.*** That is, they did not simply take a stand *for* or *against* the Project, but offered meaningful insight into how some of its components could be adjusted or changed to make it fit into the area, or be more suitable to area residents.

Table 3.3 on the following page summarizes overall issues. Most comments about the project (both positive and negative) had to do with overall growth in Kona; potential economic benefits of the project and planned infrastructure; the provision of green spaces and trails; the project's placement within Kona and particular component placement; and the proposed hospital, schools, mixed housing and affordable homes.

Growth in Kona

The most frequent and the most critical issues involved ***perceptions about the project's scale (5,000 units),*** and about its ***conformity to the Kona CDP.*** A majority of people interviewed were aware – and appreciated – that the Project is located within the Kona CDP designated growth corridor. This growth corridor was determined in the plan as an appropriate central location for future development, and most interviewees agreed growth in Kona should be directed toward the general project area, where industrial areas and roads have already been built and planned. While there is still fear that growth may lead to loss of unique community character, most recognized that Kona was going to continue to grow and that planning for this growth through the CDP makes sense.

Some interviewees were in fact pleased by the thought of a large development occurring at Kaloko Makai. However, apprehension over the Project's size was *very* often mentioned during our interviews, and was clearly the single greatest concern. Many people found this development proposal to be "too large" especially because of multiple developments concurrently proposed in the area. Even though people intellectually recognized that the proposal envisions a 30-year buildout, the visceral impact of "5,000 units" was difficult for many people to absorb.

Table 3.3 Summary of Broader Issues Related to Project

Project Specific Benefits and Concerns		
Theme	**Potentially Positive Aspects**	**Potentially Negative Aspects**
Growth in Kona	• Project is located within the Kona CDP designated growth corridor	• Apprehension over the Project's size • Needs to adhere to Kona CDP guidelines • Quick growth now occurring in Kona, leading to a sense of loss of what makes the area unique • Community would like to have some (more) input, in terms of planning • Project name could be misleading (keep traditional name of the place)
Economic Benefits and Planned Infrastructure	• More jobs, an increased tax base, and the improvements to the local infrastructure and local facilities • Planned infrastructure • More connection with existing and/or planned area developments • Long phasing period, gradual development • Increased road connectivity and the building of the Mid Level Road, and the provision of more roads	• Plan will need to provide some evidence of concurrency
Green Spaces and Trails	• Provision of open space, dryland forest, trail system, and parks	• Roads proposed as part of this Project may be cutting across ancient trail segments • Need to identify the historic trail alignment on the ground
Project Location	• Well positioned to earn community acceptance because of its placement mauka of the Queen Ka'ahumanu Highway	• Concerns about some of the plan's components, in regards to their proximity and potential impact to near shore waters and resources
Hospital, Schools, and Housing	• Community members appreciate the idea of more medical facilities projected in the area • Potential impacts medical waste could have on the environment • Schools will be needed • There is a great need for housing in Kona; project can help address need	• Proposal for placement of a hospital may allow for developing higher densities now, but it may take some time for a hospital to be built, if at all. • The location at Kaloko Makai is not right: should be in the Waikoloa region • Who is going to pay schools to be built in this economy? • Fear homes will be at a price point not accessible to the people who live and work here

According to the Project EISPN, "concepts such as *smart growth* and *sustainability* were incorporated into the Project plan, focusing on community quality of life." However, a handful of people still felt the proposed Project "needs to adhere [more] to Kona CDP guidelines and intended principles of "smart growth." These people said that they wished the Project attempted to present a better Transit-Oriented Development (TOD)

concept and incorporate even more smart growth principles such as those outlined in the Kona CDP Village Design Guidelines.[18]

While many interviewees agreed with the Kona CDP that development in this area would make the highest and best use of Kaloko Makai lands, there were some who said they still did not want to see any change to Conservation or Agricultural designations.[19]

Some community members said they hope to have more input to project planning. One person said the traditional name of the place should be preserved. According to this person, in ancient times the area was actually referred to as Kaloko Waena (center-middle) and not Makai, which would have actually been the name of the area near the shoreline. A few others simply said that use of the name "Makai" could cause opposition from people who would assume it is located on the ocean side of the highway – an area where there is much stronger opposition to any further development.

Economic Benefits and Planned Infrastructure

Most could see the potential economic benefits which will ensue from such a development in the area, including the possibility of ***more jobs, an increased tax base, and the improvements to the local infrastructure and local facilities***. For some people, the "up" side of the project's size included the idea of construction jobs extending over three decades. People especially liked the idea of planned infrastructure in the area. They talked about the longstanding need in Kona for more road connection with existing and/or planned area developments, as well as better communication between area landowners about infrastructure planning in general.

Although many appreciated the long phasing period, gradual development proposed at Kaloko Makai, some thought that the phasing not well described in the proposal. These people suggested the Plan will need to provide ***more evidence of concurrency*** between the provision of infrastructure and developments (such as housing etc). Many also suggested timing for construction would be critical, in order to avoid adding to the area's already large traffic problem.

Increased road connectivity and the building of the Mid-Level Road roused particular interest from interviewees. Issues and opportunities relating to roads and infrastructure will be explored in more detail in Section 3.4.5, when we discuss particular project components. However, the provision of more roads is seen as a major advantage for this Project:

[18] According to the Kona CDP: "These guidelines were adopted as one of the instruments of implementation of the Kona Community Development Plan (KCDP) to provide standards of development for Traditional Neighborhood Design (TND) and Transit-Oriented Design (TOD) villages. This is a form-based code, meaning it envisions and encourages a certain physical outcome at the community, BLOCK, or building level. This form is compact, walkable, and mixed-use, and is meant to be comfortable, safe, and ecologically sustainable." (Wilson Okamoto, 2008)

[19] According to the Project EISPN, the Project will need a State Land Use District Boundary Amendment to reclassify approximately 952 acres from Conservation and Agricultural Districts to the Urban District.

"Overall, it's pretty good! Now that I'm looking at it, the Kamanu extension might create connectivity all the way through to Wal-Mart and Henry St. That would provide an alternate route to all those big box stores!"

Although more jobs were mentioned as a favorable consequence of this project, a few people said they worried about these jobs actually being offered to the local Kona workforce. They suggested that developments typically bring in outside workers.

Green Spaces and Trails

The Project's provision of ***open space, dryland forest, a trail system, and parks were among the proposal's most attractive features***. Community members, especially longtime residents, appreciated the Project's intent to preserve access for recreational and/or cultural practices, and acknowledge the presence of an ancient historic trail through the property. However, some pointed out that many roads proposed as part of this Project may end up cutting across ancient trail segments, and there was some concern about the need to identify the historic Trail to the Sea's actual alignment on the ground, in order to prevent building on or destroying portions of it. Section 3.4.8 will examine the Project's Trails, Parks, and Open Space component in further detail.

Project Location

Many interviewees suggested this development is well positioned to win community acceptance because of its placement mauka of the Queen Ka'ahumanu Highway. However, some had concerns about the project's relative proximity to, and potential environmental impact on, near shore waters and resources. Specifically, there were issues regarding the placement of the waste water treatment plant (WWTP), the light industrial uses, the large amount of impervious surfaces, and suggested dry wells. The concerns were how these would increase runoff and non-point source pollution, potentially harming underground water sources or the nearby National Park's Kaloko Pond. The Project EISPN states that the EIS will include both a Ground Water and Marine Water Quality Assessment to address how to mitigate these concerns.

Hospital, Schools, and Housing

These project components will be considered at greater length below in Sections 3.4.3, 3.4.7 and 3.4.1 respectively. The following few paragraphs provide an overview.

For the hospital, there were both positive reactions and also concerns over placement and over other proposed medical sites for the area. The project's EISPN states: "*The proposed project is [currently] identified as a Neighborhood Transit Oriented Development (TOD) in the Kona Community Development Plan. Kaloko Makai will be setting aside land for development of an urgent care medical facility, as well as land for a future hospital. A hospital developer/operator is being pursued. When a hospital commits to locating a hospital at Kaloko Makai, the TOD will automatically be designated as a Regional Center TOD. Therefore, Kaloko Makai is being conceptually designed on the assumption that Kaloko Makai will be a Regional TOD.*"

A Regional Center could have a much larger land area and higher densities. The Kona CDP now targets four Regional Centers for the area from Keauhou to Keāhole; with the hospital, Kaloko Makai would become a fifth. [20] While community members seemed to appreciate the idea of more medical facilities projected in the area, some saw this proposal to build a hospital as a "poor attempt" at getting higher densities on the proposed parcel; these people felt that authorizing higher densities would result in instant benefits for the developer, while the community benefit of a hospital may be delivered much later, or perhaps never actually materialize at all. Additionally, a few people had concerns about the potential environmental impacts of medical waste could have on the environment, and one or two – definitely a minority among the interviewees – thought the Waikoloa region would be a better site.

The planned provision of three school sites seemed to please most people. However, the question of "who is going to pay for actual construction?" often came up. Finally – although everybody we interviewed said they perceived a great need for housing in Kona and were happy to see more housing being planned – many or most had a hard time trusting that Kaloko Makai would actually be priced at levels affordable for the Kona workforce.

3.4 Discussion About Specific Project Components

After having identified broad areas of concern in West Hawai'i, and general impressions about the Project in general, interviewees were asked about their thoughts about specific project components – specifically, these eight main project components:

1. Residential Housing
2. Phasing
3. Hospital
4. Transit-Oriented Development under the Kona Community Development Plan
5. Roads and Utility Infrastructure
6. Retail, Commercial, and High-Tech Business Development
7. Schools
8. Trails, Parks, and Open Space

Issues relating to housing, namely Kona's current need for more affordable housing, as well as project phasing were particularly important to these interviewees. Project phasing issues in regards to the housing, infrastructure and industrial-commercial components, as well as the plans for the Mid-Level Road were also "hot button" topics. Therefore, these topics will be covered first. (It should, however, be noted that proper alignment and protection of the trail is also very important to certain groups.)

[20] Pages 4-128 and 4-129 of the Kona CDP have language about hospitals and Regional status: "To encourage the private sector to negotiate a site for the hospital, the TOD in which the hospital decides to locate within shall be automatically designated a Regional Center TOD if the Official Kona Land Use Map has designated it as a Neighborhood TOD. As a Regional Center TOD, there would be incentives for medical offices and other hospital-related businesses to develop in the vicinity"

3.4.1 Residential Housing

Interviewees were asked if there really is a need for housing among the existing workforce in Kona – and, if so, what type of housing was needed, and what they thought would determine whether this project does a good job of meeting this need.

They were then asked whether they thought the affordable housing approach presented in this proposal seemed like a good approach and if they perceived it as any better or worse than other developers' approaches to affordable housing. We also asked them what their ideas would be about a better way to mix affordable units into an overall development – mix them up with the market rate units, or have some concentrated pockets. Interviewees had strong opinions to share about affordable housing.

Residential Housing Need in Kona

The largest portion of the Project involves the construction of 5,000 new single- and multi-family residential units at low- and medium-densities over about 30 years, with an "affordable" component set at 20% of units (about 1,000), targeting residents with income levels between 60%-140% of area median income.

The EISPN states that the Project is a response to a need for more housing for Kona workers. Higher-density housing will presumably be more affordable. The Kona CDP permits higher densities for TODs, and Kaloko Makai is one of the first developments proposed that would follow these provisions.

As previously noted, there was ***substantial agreement that housing is needed (in the future if not immediately), but there were also substantial concerns about the size of the Project.*** For many, there was a fear that this project could end up another sprawling subdivision, with too many units that would inevitably add to traffic.

However, some local residents emphasized the positive opportunities in the Project:

> *"It's a large project in a good location. That land is marginal and not good for agriculture. Its highest and best use is for development."*
>
> *"If this is built, you'll put people to work and they'll have some stability. Construction workers have been testifying for several developments these days."*
>
> *"While government has taken on the job of building housing in some areas, history tells us that the housing problem is probably best solved by the private sector."*

Some people did not think this much housing (5,000 units) is needed in Kona. First, a number of people pointed to current recession impacts on the housing market – substantial vacancies in (i.e., lack of demand for) existing new housing projects. While many interviewees assumed Kona's growth will resume as the economy recovers, some

interviewees worried that a mix of structural economic changes and persisting air quality problems could put a permanent crimp in Kona tourism and housing values.

Second, some suggested that developers keep planning and building for an upscale (often second-home) market that is no longer investing in the region. Despite the project's stated intent to market the project to the local workforce rather than affluent off-islanders, there was suspicion among some interviewees the project would not actually respond to the needs of the local population. There was also a certain level of skepticism about what the demand will actually be in 30 years.

> *"The need is first for jobs. As far as housing, we have quite a few rentals. But if you don't have a job or any stability, you're not going to buy a house."*

> *"There's a need first and foremost for affordable rentals. That word 'affordable' needs a specific definition. I can't remember the last time I saw a house here in Kona for $152K."*

> *"Demand is not really the concern. The concern is with affordable. What does affordable mean for the developer? We need to be able to afford it if it is affordable housing. I understand that the developer needs to make money. If the developer simply sells units at a discounted price, it doesn't mean that they will sell for that in the future."*

> *"There is so much on the market now. The market is still flooded with bank-owned properties, so right now it's challenging."*

> *"A more important conversation is the need for basic infrastructure. It's not fair to say 'people are screaming for affordable housing,' and using that as a reason to ignore basic infrastructure. And we're in a dry place – we must confront whether we have enough water to support that level of growth. For housing, everybody needs a hook-up!"*

Regarding project design, a few interviewees felt the conceptual plan failed to convey a sense of community, and the relationships of the lots within the plan could be improved to increase connectivity.

Affordable Housing Component

Definition of "Affordable:" Almost every single interviewee told us that *affordable homes*, as defined by the US Department of Housing and Urban Development (HUD) and what is currently affordable to people living and working in Kona are two different things. Whether or not this project offers "affordable" homes, the consensus among interviewees was that the ***lowest-income groups cannot meet HUD's "affordable housing" criteria***. Several people noted that ***longtime "local" area residents (such as Native Hawaiians) were particularly affected by this issue.***

> *"Really, affordable here is $140,000 and below."*

> *"Affordable housing includes people who make more than 140% of median income. What they are providing is housing for the middle class, not working local people."*

> *"The people I deal with are often Hawaiian or Filipino trying to support large families on hotel worker salaries. The system effectively shuts them out."*

This theme was so strong and frequent that a chapter within Volume 2 ("Housing Issues") examines available Census data to determine the extent to which there are actually inequities built into the HUD and County guidelines for eligibility for "affordable" housing.

Many interviewees liked the idea of a varied mix of housing being offered by the private sector at market-driven prices. But others wanted this project – or any project – to provide an even larger share of affordable homes.

> *"We need all types, not necessarily MacMansions, but all socio-economic groups, including the elderly or others on fixed income. The Project's affordable housing approach seems reasonable; I think one of the things I like is that it's private-sector, market driven. So it is not just trying to do subsidized housing and make the numbers work."*

> *"They offer 20% here, but other developments have represented higher."*

> *"The newer trend is to think in terms of affordable 'community,' not just affordable 'housing.' The true cost includes getting to places to shop, work, education, not just the cost of the house alone."*

Concentration of Affordable Component: The Project EISPN specifies that the affordable housing component will be provided (in accordance with County rules) and that the mix will be integrated into the master plan. In accordance with this, most interviewees strongly felt it would be ***better to disperse than to isolate lower-income housing.***

> *"Much better to sprinkle the affordable units – no ghettoes!"*

> *"Segregating people in an 'affordable' housing area, away from the higher-end homes, doesn't necessarily build good communities."*

3.4.2 Phasing (Housing, Infrastructure, Industrial-Commercial)

In order to elicit reaction to proposed phasing and timetables, we shared information about project phasing from the Kaloko Makai Environmental Impact Statement Preparation Notice (EISPN) prepared by the Wilson Okamoto Corporation in Sept. 2010.

> Development of the project is anticipated to commence with the construction of infrastructure improvements to begin immediately following the necessary land use approvals and permits. The delivery of the first residential homes is scheduled for 2015. The project proposes to develop major infrastructure by 2025. Kaloko Makai will be implemented in three phases and completed in 2035. Construction of residential units will be on a phased basis according to market demand. (P. 2-9)

(It should be noted that developer plans for phasing continued to evolve during and after the interviews, and have become more specific.)

Many viewed the project's phasing favorably, and were content with the proposal to start the construction with infrastructure improvements. However, in regard to major infrastructure being provided in 20 years, many also said the community just can't wait that long.

> *"The developer's need to phase the project according to market conditions is understandable from an economic perspective, but may be a very hard sell to a community that has heard so many promises and, often seen different results. SCD is already on hold with Kaloko Heights, and it is unknown when that important community infrastructure will be provided."*

There was also general ***approval for the idea that industrial/commercial property on Queen Ka'ahumanu Highway should be the first project phase:***

> *You're building for a hoped-for market that won't evolve until new job opportunities are in place. So get that commercial stuff up and running first!*

The long phasing (over 30 years), which could provide construction jobs for years to come, seemed favorable to many. However, based on experience from other projects, interviewees were ***apprehensive about such a long project phasing approach***. They also had concerns about likely government conditions for the project – how, in their perception, these never seem to be timed and overseen adequately, and for which there has been no consistent follow-through. Some interviewees recommended certain conditions be imposed on particular phases.

> *"They have to do it this way, and each condition should match: Conditions should be imposed in phases too, not only when project is finished."*

> *"You see, there is a history here of people proposing thing and getting approvals for projects and they make promises that when they build this, they have to build this. But they end up dragging on and whatever they promised never ends up being built. They say 30 years – who knows what could happen over 30 years?"*

3.4.3 Hospital

Interviewees were asked whether they felt existing hospitals for West Hawai'i (the 94-bed Kona Community Hospital 11 miles south of the Project and the 50-bed, North Hawai'i Community Hospital in Waimea) were adequate to cover the growth from this

proposal and other projects in West Hawai'i. They were also asked whether the new regional hospital site proposed at Kaloko Makai seemed a good location.

Need for a New Hospital in North Kona

In regards to the need for a hospital in the region, ***most people felt the current facilities in the region are not adequate*** to cover current and future demand. .

> *"The South Kona hospital is only accessible by a private two-lane road. You can't expand the medical facility there with such inadequate road access."*

> *"The availability of diverse medical services in West Hawai'i is problematic. There is a shortage of facilities and medical professionals. Some residents have moved away because of this and others, especially, seniors, may not want to move here because of these shortages. There is no question that additional hospital/medical facilities are needed in North Kona, especially in the project area, but it is not certain the State will approve a certificate of need. On the other hand, maybe a new private hospital is the answer."*

However many interviewees were aware of other proposals in the region for health care facilities. Some interviewees said there was competition for the "hospital spot" supported by the Kona CDP, because other area developers are planning to site a full service hospital within their developments as well. Others said smaller facilities, such as clinics, rather than full-service hospitals, are already being built/planned throughout the area. (It should be noted that smaller facilities would be unable to offer services that a full-service hospital would, such as specialty surgery and testing), and a few even felt Kona's medical needs might better be addressed by many smaller medical facilities rather than one large regional hospital.

Because of this perceived competition for medical sites, ***many interviewees questioned whether the project's designation of a hospital was likely to become reality.***

> *"Sure, we need more hospitals and if everything gets built that is planned, we are going to need it. But right now there are not enough homes to support it. These things take years, and cost too much money."*

> *"Our current facilities are not adequate. But I recall at least five other major medical facilities proposed in this urban growth area. For some, land actually has already been acquired; others consistently displayed as likely, and working on agreements. This is not the only proposed site. Kaiser Permanente owns a site that is north of Kealakehe Parkway, just mauka of Queen Ka'ahumanu. Pālama Nui has always proposed a medical campus, in the area of Ane Keohokalole and University Drive. The QLT long-range projection also shows one. La'i'opua 2020 is looking at potential partnerships on DHHL land. So there is quite a variety of possible places!"*

"Other sites have also been proposed. The word 'potential' is often used in regard to hospitals and schools and such."

"Based on the theory they'll find somebody, which they haven't been able to do in last 12 years at least, that means they're designing it on the anticipation of something that doesn't exist"

"At the time the Kona CDP was drafted, there didn't seem to be any viable hospital site. Since then, many have been suggested. The developer needs to be pretty confident the hospital would occur, because the situation has changed. And now it seems like more smaller facilities would be better than one large one hospital."

Some interviewees suggested other solutions to respond to the need for a hospital in the region. They offered a variety of ideas, including ***a desire for the hospital to be more of an economic driver*** than a medical amenity alone:

"I am thinking the hospital should be bigger, such as tying into a research facility. Maybe it should have some kind of specialty, like sports medicine. There are no orthopedic surgeons on this island, so maybe having a specialty like that could actually bring people to this island."

"If the hospital wants to be there, make it a research hospital, a component of some economic driver."

"We need a medical center, not just a hospital – i.e., offices and clinics. La'i'opua will have a West Hawai'i Community Health Center, which makes a nice synergy. And Kaiser is also moving out there somewhere."

Although the commitment of a hospital was generally well received by community members, ***interviewees repeatedly asked whether Stanford Carr Development was committing a site, or whether it would actually build (or otherwise assure construction of) the medical facility itself.***[21] Some people were dubious that any new hospital anywhere in Kona will be feasible in the foreseeable future. Those people commented on the struggling economy and the lack of doctors, nurses, and staff for existing hospitals on the island, all of which they said pointed to problems that must be solved before a new hospital becomes feasible.

Hospital Location

Because of the population growth in North Kona, most interviewees liked the idea of a hospital sited farther north than the current one in South Kona. And most seemed to think ***siting of a hospital in the Project area would be appropriate***, stating:

[21] However, Policy LU-2.6 of the Kona CDP says "public financing sources shall pay 100%" for costs associated with "Major proposed trunk transit route," among other development components.

"This location is good. It is close to the airport, close to schools, pretty centrally located, and fits into area that needs it."

"I don't think you could find a better location – very central. It covers the mauka area, too. I live on the upper road, and would be just 10 minutes down to this area. Same from Kailua, just 10 minutes. That's where most of the traffic is – to me it's the center."

One person suggested a hospital would make more sense sited more to the north, perhaps in Waikoloa, as Kona already has a hospital. A somewhat more frequent alternative was to locate a new hospital more makai and/or closer to Kailua town.

"I am happy it's included in this project, though a much better site would be down by the Civic Center, because that's where all the government services are concentrated. It is better if it's all centralized"

"My view is the hospital should be more focal to the evolving urban core of Kailua."

In regards to other concerns about the placement of a Regional Hospital at Kaloko Makai, we were told that this proposed ***hospital site is too close to shoreline***, potentially causing issues with the management of waste and other harmful contaminants:

"My concern is the medical waste management issues – this hospital would be just a mile from the coast and upslope from the National Park. The EPA and the NPS both have growing concerns about emerging contaminants, pharmaceutical waste, and human waste near sensitive eco-systems."

(It should perhaps be noted, however, that most hospitals throughout the state are located within a mile of the coast.)

Timing

Finally, the lack of a specific timetable for the hospital phasing bothered several interviewees, as its provision was the core basis for the Regional TOD proposal:

"If the hospital were truly a core component and a realistic driver for change to the more dense Regional TOD, then one would expect that that core/focal element would be early in the project."

"I don't think the hospital can wait. We need it in the next five years. If you don't have an anchor like that, whoever comes up with the first hospital, that'll be it. If he's hanging his hat on this being the draw, he [Stanford Carr] needs to get it in place fast."

3.4.4 Transit-Oriented Development (TOD) Under the Kona CDP

We asked interviewees whether they were aware of the Kona Community Development Plan (CDP) and whether they were involved in the community outreach efforts that led to drafting of the plan. The great majority of interviewees were aware of the CDP, and many were involved in the efforts which led to it. Because of this, many were able to speak not only to the appropriateness a TOD placement at Kaloko Makai, but also to whether or not they had concerns about whether the TOD would be a Neighborhood or Regional Center TOD with a hospital.

Placement of a TOD at Kaloko Makai

The Kona CDP designates Kaloko Makai as a Neighborhood TOD Center. This County document was enacted into law in 2008 after a series of community outreach efforts conducted over several years. Not surprisingly, most interviewees were aware not only of the plan, but also of the plan's vision for a TOD at Kaloko Makai, and there was ***general concurrence the project location conformed to the CDP.***

> *"Yes, it's a good place for a TOD. If I were a developer, I'd target that area. I've lived here long enough to know what would work and what doesn't. The closer you are to the Mid-Level Road, it is definitely more of an advantage. Again, this is corridor to government services and traversing back and forth to the core areas of Kailua-Kona."*
>
> *"Yes, it follows the documented vision."*
>
> *"Yes, especially considering we already have two industrial parks near there. It's already slated for development, and it is mauka of the highway."*

TOD Becoming a Regional as Opposed to a Neighborhood Center

A Regional Center could have a much larger land area and higher densities than a Neighborhood TOD. The Kona CDP now targets four Regional Centers for the area from Keauhou to Keāhole. With the hospital, Kaloko Makai would become a fifth. Many interviewees had been and continue to be involved with the Kona CDP. Because of this, they often had strong feelings in regards to making modifications to the community plan.

There was a particular split among interviewees about creating a fifth Regional TOD Center. Many – including some people heavily involved in the Kona CDP process – said there are currently enough Regional Centers planned in the Kona region, stressing that the Plan's current four Regional Centers were originally chosen because of their location on existing or planned central intersections. Others said promoting higher densities in an already growing area (by supporting a Regional Center TOD) made a good deal of sense.

Table 3.4 summarizes interviewee thoughts and concerns about the Project's proposal to develop a Regional Center TOD at Kaloko Makai with a hospital site, in lieu of a Neighborhood Center, as was proposed in the Kona CDP:

Table 3.4 Regional or Neighborhood Center TOD

Designating Kaloko Makai as a Regional (Rather than Neighborhood) TOD Center	
Positive(s)	**Negative(s)**
A Regional TOD is good idea; TOD placement is appropriate, and Kaloko Makai is an ideal spot for a hospital	Hospital is not needed, need to commit access if offering hospital
Forward thinking: A TOD in this location follows the Kona CDP vision; a hospital is a plus and a good source of financial support, development of such a TOD could serve as model for other districts	There are enough Regional Centers, should instead provide higher residential density Neighborhood Centers
Larger Regional preferable to infuse money in the economy	Not originally designated as Regional TOD; there is no need for a regional TOD
Appropriate to have higher densities at Kaloko Makai	Want hospital but would rather keep neighborhood feel; smaller medical sites may make more sense
Project is already within a corridor to government services, in a central location already ready to be developed	There is a disconnect between this proposal and the intent of the KCDP; the placement of TOD should be on central intersections

It should be noted that the change from a Neighborhood Center TOD to a Regional Center TOD would not actually require a plan *amendment.* The plan states, "To encourage the private sector to negotiate a site for the hospital, the TOD in which the hospital decides to locate within shall be ***automatically*** designated a Regional Center TOD if the Official Kona Land Use Map has designated it as a Neighborhood TOD."[22] Still, some interviewees focused more on the importance of limiting the number of Regional TODs and the significance of placing Regional Center TOD's with an urban core situated along a main transportation artery, rather than this provision when objecting to a Regional Center TOD at Kaloko Makai.

However, we also heard positive comments about the desirability of a Regional Center TOD with a Hospital site at Kaloko Makai. Some people thought it made sense to have a Regional TOD because a hospital is greatly needed in the region, and because they saw Kaloko Makai as the best place to direct growth over the next decades. These people were often aware of – and agreed with – the idea that a hospital in North Kona is such a pressing need that the Kona CDP appropriately calls for the possibility of converting a Neighborhood TOD to a Regional TOD if a hospital is provided.

> *"Kaloko Makai would be the logical and accessible place for West Hawai'i to grow into – it has been in development plans for a long time. I think it would be better to be Regional. The proximity to light industrial area at bottom, all the neighborhoods surrounding it – as a Regional Center, there will be better transportation nodes and freeways."*
>
> *"I think it's necessary to think in future tense, the Regional is very important to me. Seeing what Kona has been and become, need to keep thinking about future."*

[22] Kona CDP, Pages 4-128 and 4-129, emphasis added.

3.4.5 Roads and Utility Infrastructure

After discussing the proposed segment for the long-planned Mid-Level Road, we asked interviewees if they had any questions or advice for the developer about the importance of getting it built. We then asked them if they saw any other opportunities for this project to help with solving traffic issues, either from the project itself or from general growth.

Proposed New Roads

Interviewees favored the early completion of Kamanu, Maiau and the Mid-Level Road, but also a connection at Hulikoa Street. According to virtually all interviewees, ***the most critical aspect of the proposal has to do with the building of the Mid-Level Road (Ane Keohokalole Highway).*** The Mid-Level Road will help alleviate, traffic as all travel won't have to occur only on Queen Ka'ahumanu Highway:

> *"The key component is definitely the Mid Level Road. It would take traffic off of Queen Ka'ahumanu. Hina Lani already resolves some of the mauka-makai traffic challenge. So getting just the Mid-Level Road built, as well as providing a connection to Kaimikani Street, is a priority!"*

> *"Making that happen is necessary for any development to work in this general area. It will help with transiting through the subdivision, getting to services, creating much better north-south flow etc. It is imperative for any of this to happen."*

> *"The mid-level connection to Kaiminani is the big banana, the key, because it would connect to the college in one direction, and you'd also be able to go to civic center on Kealakehe Parkway."*

> *"The Mid Level Road is critical. This is an important project for a number of reasons – one of them is that construction jobs are badly needed. This project couldn't start fast enough for me!"*

Ane Keohokalole Highway, like all major arterials, is planned as a taxpayer-funded road built by government. The project's EISPN states:

> The Federal Highways Administration (FHWA), in cooperation with the State Department of Transportation and the County of Hawaii is proposing the Ane Keohokalole Highway (Mid-Level Road) from Palani Street to Hina Lani Street. The proposed roadway will provide a link, approximately 3 miles long, and is parallel to Queen Kaahumanu Highway. The proposed roadway would function as a major collector roadway and consist of four lanes of two-way vehicular traffic. [P. 3-26]

However, a few people we talked to felt strongly the ***developer should bear the cost of its construction.*** The reason for this assertion – which would obviously increase the price of housing if carried out – seemed to be rooted in both the community's historical distrust that government would provide needed infrastructure and also in the general

perception that developers have deep pockets and should be "giving back" more to the community.

> *"SCD should cover the cost of the Ane Keohokalole Highway (Mid-Level Road) portion through its property. I don't see it in the plan, but, as previously noted, it is important to have this roadway segment completed. SCD should pay for this."*

> *"It is absolutely critical that the Mid-Level Road be built now – The Recovery Act won't be there forever. As far as the intersecting roadway system is concerned, it should not be all that expensive if you do it at one time. I don't know how in the world to schedule something like that, because that means an awful lot of up-front money would be spent. However, this county's proportional share of stimulus money is around $700M. They'll have to do more stimulus, and we have to be ready."*

> *"There is a yin and yang to it. Doing that part of Mid-Level Road will help. But to afford to do that, they will have to build a lot more units. So we will get good with bad..."*

If this condition were actually imposed, it would of course increase the price of Kaloko Makai homes substantially – an issue that was little discussed by those who wanted "the developer" to bear the cost. However, many of those who advanced this idea did say they knew it would be expensive and may cause potential delays and/or stop this project altogether. According to one interviewee, the cost of building the Mid-Level Road may actually be unusually elevated:

> *"The first section of the Mid-Level Road was built using federal funds and needed to meet federal standards. This drove the price way up. Design of the Kaloko Makai segment will have to be consistent with standards for what's been done, what's being done now."*

Road Re-Alignments

The current plan's ***proposed alignment of the Mid-Level Road*** seemed to raise some concerns with some interviewees. Others also expressed concerns about the changes made to the ***Kamanu Street alignment*** from what was discussed in the Kona CDP:

> *"The alignment of Mid-level Road needs to follow the alignment shown on the CDP. Kamanu Street also needs to follow the preliminary design. The Hina Lani Intersection was built to increase the capacity of connectors."*

> *"The original alignment of Kamanu Street was supposed to lead through the Kaloko industrial Park area directly south of the project, go around to the water tank and then through the industrial Park- The owner of the Industrial Park set aside land for that. He wouldn't be happy to have it veer away from his property*

like that. It wasn't decided if the road was going to connect with the industrial park in the middle, or at the top, but that guy will want his connection there."

To address a better connection between industrial uses proposed as part of the project (to be addressed in more detail in the subsequent Section 3.4.6), someone suggested the realignment of Hina Lani Street through SCD as well:

"I would suggest a change to the Hina Lani route as shown on the map in order to better facilitate the traffic flow on the collector and allow better integration into the light industrial area."

Phasing of Road Construction

Kona's traffic problems – despite some alleviation from widening of Queen Ka'ahumanu Highway near Kailua – are so longstanding that many people assumed the congestion would continue whether or not the Project's projected roads are built. Some also ***feared that any mis-phasing for road construction would aggravate the traffic situation:***

"The biggest fear I have is Hina Lani being overtaxed, so phasing in would have to be done with other project roadways, to avoid putting all the pressure on Hina Lani. It's always a concern that infrastructure could get out of synch with actual population growth."

"People buying a new home may want to have services and infrastructure immediately after they purchase of a home. Timing is big part of it."

"In general, when you add 5,000 units, they all have to come out on either old Māmalahoa Highway or Queen Ka'ahumanu. Even with the Mid-Level Road, you'll have to get to one of those major highways. The project impacts are adding to, not resolving needs; the development will be constrained by what's on either end."

Other Infrastructure Issues

Other concerns involved ***water*** (both additional in an area which is already experiencing shortages and the treatment of it), and non-point source pollution issues. Interviewees felt the Waste Water Treatment Plant would be a key benefit to the Project, but also felt ***more in-depth planning (or more information) about water and wastewater is needed for a project this size***. It should be noted that an EIS would normally address most or all of these types of issues.

"With so many impermeable surfaces in project, we feel there's not enough infrastructure to deal with the run-off. Dry wells are what's used in the county, and there have been no anti-pollution measures in the design of those dry wells."

"You can't just provide housing. Water will also be critical."

"I think that the placement of a WWTP is huge, that they're planning to include all that in project to mitigate impacts is really great."

Finally, some people offered suggestions for improving the design of the proposal's services and infrastructure:

"As a trail-oriented person, I'd just like to see special treatment for the place where trail crosses the road – safety features."

"I would like to see more design for multi-modal, shared use path for bikers, skaters, and all alternative non-motorized modes – such as open shoulders to provide transportation for more skilled cyclists."

3.4.6 Retail, Commercial and High-Tech Business Development

Interviewees were asked for reaction to the proposed plans for about 120 acres of commercial space in various locations – of which the largest would be a business park off Queen Ka'ahumanu Highway that may potentially include scientific research & development facilities, plus some retail dispersed throughout. We asked if these proposed uses and locations seemed appropriate.

The proposed ***location of most industrial uses along Queen Ka'ahumanu Highway was generally well received.*** (Someone observed, however, that the County of Hawai'i may require an 800-foot setback from the highway for these uses, and said this may not be conducive to successful commerce.) People also liked the idea of a business park with scientific, research, and development facilities in that location:

"Location-wise, this project's retail/commercial/high tech components are very good, largely because of their proximity and adjacency to Hina Lani Street."

"The Project's proximity to both NELHA and to the new West Hawai'i campus, as well as to the National Park, makes it a good area for that sort of product! It will be considered appropriate in-fill if the right tenants can be recruited. No need for big boxes there!"

"That kind of element provides places that small businesses need ...and in this marketplace opportunities are still not sufficient even today. There is especially a need for places that have more of a finished appearance than light industrial areas usually do. That location by the airport would be very beneficial."

On the other hand, although the plans seemed to make sense to most, some questioned the need for additional substantial supply[23] of ***commercial, retail, and high tech development facilities during the current poor economy***, when so much of Kona's existing inventory lays vacant. Someone even questioned whether tech

[23] **Note:** These comments were in response to an older project description (Appendix B) that has since changed. SCD and its consultants came to the same conclusion and reduced planned industrial space.

development would be allowable in a neighborhood TOD. Along with lack of demand for commercial and retail spaces, some even suggested the long-range demand for high tech may be difficult to anticipate and plan for:

"A tech area would be a special area – I am not 100% sure that that would be allowed in a neighborhood development; It would have to be a special, separate area. We have a fair amount of commercial development already in the area."

"If there were a demand for that much more light commercial ... The concern I have is that lots of Kaloko Industrial Park has not yet been absorbed. Half of it is empty, and there is more to be developed."

"I am concerned about demand for light industrial or high tech. One would have to create demand for high-tech, it requires lots of public-private effort. You need incentives to get them in. NELHA is tied to the ocean, but more terrestrial activities would have to be brought in. I'd be concerned about what the market can sustain."

As with the proposed roads and utility infrastructure components of this Project, the industrial component raised some concerns in regards to how this could potentially have an ***impact on local groundwater and coastal waters***:

"That part of the development will be sandwiched between two existing industrial areas. There are waste issues associated with these types businesses. USGS has found contaminants in our dry wells in the past. The existing industrial park is an urban area with contaminants moving directly to groundwater that goes quickly to the National Park and then to ocean. The exact source of release is not known; however, there was a spill of some sort in the industrial park in the 90s. It is assumed that anything upslope would be contributing to non-point source pollution."

Some final recommendations heard in regards to the industrial areas included

"Move it mauka – we have enough on the highway."

"Will there be green space or a buffer within the industrial area? Industrial areas don't have to be ugly! A lot of effort was put into landscaping in the Kaloko Industrial Area, and I think that's an important requirement that makes an industrial area a lot more attractive."

3.4.7 Schools

At issue were proposed sites for two elementary schools and a middle school.. ***Interviewees generally responded favorably to the idea of more schools to serve existing and future students.*** However, some also said that although they appreciated the SCD effort to provide school sites, land alone would not be enough – they wanted the developer actually to build the school structures early on and then turn them over to the State for future need. Others recognized this is not the normal procedure and would

increase the price of housing, but still thought the developer needs to be involved in assuring the schools become a reality.

"Kealakehe Elementary, Intermediate and High Schools are already open and located nearby. I am not saying schools are not needed; at full build, it will become necessary, we would have to have more schools. The costs of any impacts generated by the development should be paid by that development."

"It will be years before they develop the school, so the designation of the land is good – it's all you can do! The State doesn't have money to hire teachers anyway!"

"I don't think the State has the capacity to get things done in time and on budget. It will take developer working closely with the State to make sure [schools get built] on time."

The persistent theme that the developer should provide substantial "upfront" infrastructure (schools, major regional highway, even the hospital structure) – with limited thought about implications for housing affordability – seems to reflect ***a pervasive distrust in Kona that government can actually deliver infrastructure when needed.*** It may also reflect an implicit assumption that private-sector housing developments are targeted mostly to upscale purchasers – and that it is therefore financially feasible to extract some of the developer profit and/or that the additions to housing price would not really affect the local economy.

Along these lines, we also uncovered some questions about the assumptions made about the future demographics of the area. Some people we spoke to said that from what they could see of the proposed plan, it could attract an older, financially sound demographic and not young families with school-aged children. (This is contrary to developer representations, though it should be noted such representations were not emphasized in the EISPN project, including the portions shared with interviewees.)

Because of this assumed (or feared) older and upscale market, some interviewees feared schools would never materialize on the site. Again, this may be a case of people talking less about this project than about their perceived cumulative experience with development in Kona. By becoming a Regional Center TOD the development effectively could provide a greater mix of housing, as greater densities would be allowed within its urban core. These mixed-use and multi-unit dwellings are actually intended to lower housing costs across the entire development, making it affordable for the Kona workforce, especially those with families.

Finally, a few people who doubted the real need for regular schools in this project thought the sites could still be used for alternative educational purposes.

"I would say what will work out there (Kaloko Makai) will be specialty schools, such as trade schools and charter schools that could lace themselves into the plan."

3.4.8 Trails, Parks, and Open Space

We showed interviewees that the proposal included a historic trail, 65 acres of interconnected park space, and 150 acres of dryland forest open space area. We then asked whether there were any particular community needs they thought could be met with the development of these new areas, as well as what sorts of facilities should be provided. Many interviewees ***approved the Project proposing so much green space and protection of cultural/natural landscapes***.

Dryland Forest

This was generally seen as a particularly valued project amenity.

> *"Other developments don't happen to have such a nice dryland forest that can be incorporated into their development! I view that as a gift. It makes this property quite unique; it contains some very special botanical resources, and I'm very glad they'll set it aside."*

> *"This is the wave of future; walkable green spaces, and taking advantage of historic trails as assets rather than something inconvenient to work around."*

> *"The dryland forest is an attraction for the larger community, because native dryland forest areas are becoming rare; this could offer a tremendous educational benefit. If the West Hawai'i University of Hawai'i campus gets built nearby, it would be an educational resource for them as well."*

Trail

Incorporating the historic Road to the Sea (or Kohanaiki) Trail was also seen as a ***highly desirable project characteristic***. However, a number of interviewees said ***more work needs to be done to locate (and define) the historic Trail alignment*** meandering through the lower portion of the parcel. Although interviewees seemed optimistic about the prospects of working with SCD to make that happen, the history of the events which unfolded during the process of making the plans for Kaloko Heights (another Stanford Carr development) remained fresh in people's memories.

In the opinion of some interviewees, SCD failed to involve the community early enough into the Project for its development at Kaloko Heights. The view was that many problems could have easily been avoided if SCD had consulted more with area residents, descendants and other community members instead of ignoring the trail's presence. Although the "messy" history still remains in people memories, the efforts to incorporate the trail into the plan, and their attempt to try to locate its alignment have not gone unnoticed at Kaloko Makai:

> *"For Kaloko Makai, they did much better. They did not show up with subdivision already mapped out. Instead, they invited [us] to check where their archaeologist*

> *thought the trail goes, and acknowledged the importance of consulting lineal descendants. The whole approach was much more thoughtful and much more respectful. The feeling of being included early made a great difference."*

> *"I find that to be a strong positive for the project. Any time you allow public access, it makes a project stronger. When developments stop access to previously accessible areas, it hurts the community. It is very important to provide people access to natural areas."*

Some questions were also brought up as to how the developer would respond if other trail segments were to be uncovered throughout the parcel. The Historic Trail has been part of the regional cultural landscape and played a role in getting people back and forth across the ahupua'a for a very long time:

> *"The Road to the Sea Trail has been identified as the main artery for the ahupua'a, connecting fish ponds with homesteads. These were places where memories were passed on to living generations of kūpuna or ancestors going up and down the trail. So much elevation change with this trail that many different types of things were gathered up and down the trail as people went. While the trail is an extremely important feature, there are also cave sites, burials, home sites – all attached to currently living people with very deep connections to them."*

> *"This trail served and provided for my grandparents, as this was the main access to the shoreline."*

Other Parks and Green Space

Although most people were pleased this plan leaves many acres of green space intact and/or protected, interviewees suggested that with such a large development, ***parks and open space need to be well maintained for active use***, not just passive uses or unused space. Community members had various ideas and suggestions in regard to green space, trails, and community spaces:

> *"There's no real park land from down from town to Waikoloa – no soccer fields, or ball parks. Everything takes place in town. The dryland forest would not address this, nor would a trail. We need more active playing fields."*

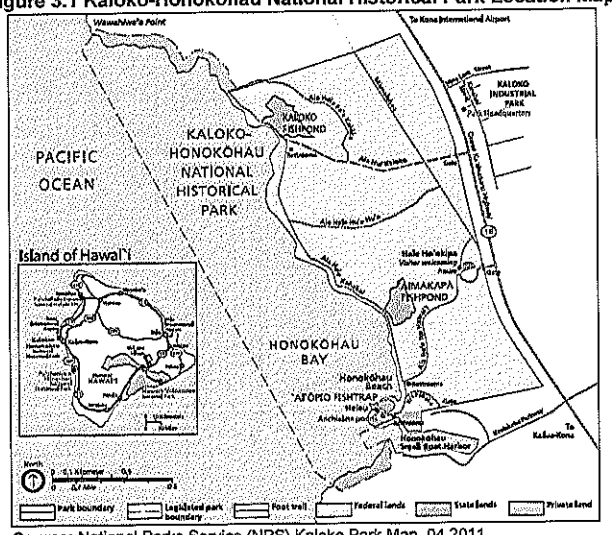
> *"Ideally, what I'd like to see is that the trail becomes an attractive alternative to walking along roads – e.g., for after-work walk or school children to schools. Make it a living, relevant feature, not just something to look at and say, 'Oh, that's what used to be!' If dryland forest plants can be planted adjacent, it would be much more pleasant. I have yet to see that happen, but it's not out of the question!"*

> *"What we need is to have more open, maintained, accessible space. It has to be open and maintained. People have to feel safe there. If it is not maintained, you're going to have people growing pakalolo over there, more crime etc."*

3.5 Particular National Park Service (NPS) Concerns

We did not ask interviewees direct questions about the impact of the project on neighboring parcels. However, we made a conscious attempt to try to contact nearby and adjacent landowners in order to make sure to capture their concerns, if any. Although we did not get a response from all the people we attempted to reach, we did have an opportunity to speak with four NPS staff[24] on March 10, 2010. The northern part of the Kaloko-Honokōhau National Historical Park is located directly across Queen Ka'ahumanu Highway makai of the Project site (Figure 3.1). The Kaloko Fishpond is located directly down slope from Hina Lani Street, which is at center of the project site.

Figure 3.1 Kaloko-Honokōhau National Historical Park Location Map



Source: National Parks Service (NPS) Kaloko Park Map. 04,2011
http://www.nps.gov/kaho/planyourvisit/loader.cfm?csModule=security/getfile&PageID=124438

According to its website,[25] the Park was:

> Established in 1978 for the preservation, protection and interpretation of traditional native Hawaiian activities and culture, Kaloko-Honokōhau NHP is an

[24] Kathy Billings, Park Superintendent, Kaloko-Honokōhau and Pu'uhonua O Honaunau National Historical Parks; Aric Arakaki, Superintendent, Ala Kahakai National Historic Trail; Sallie Beavers, Marine Ecologist and Chief of Resources; Rick Gmirkin, Community Archaeologist, Ala Kahakai National Historic Trail, Interview Conducted on March 10, 2011.

[25] http://www.nps.gov/kaho/faqs.htm

> 1,160-acre park full of incredible cultural and historical significance. It is the site of an ancient Hawaiian settlement which encompasses portions of four different ahupua'a, or traditional sea to mountain land divisions. Resources include fishponds, kahua (house site platforms), ki'i pōhaku (petroglyphs), hōlua (stone slide), and heiau (religious site).

Additionally, the Ala Kahakai National Historic Trail Program began in 2000, when the Ala Kahakai National Historic Trail was added to the National Park Service's inventory of federal trails within its system. This coastal trail is of considerable historical and cultural significance. The Project EISPN discussed the preservation of the Road to the Sea which makes its way to the ocean, from the inland sections mauka of the Project Site, connecting to an ancient network of trails, including the Ala Kahakai Trail. The National Park Service Ala Kahakai National Historic Trail Staff therefore also spoke to us.

However, the interview responses were limited and largely focused on referring us to NPS/Ala Kahakai comments in their letter responding to the project EISPN. In this letter, the NPS specified a number of issues of concerns. Ways they suggested these concerns be addressed are outlined below:

Table 3.5 NPS Comment Letter Concerns

Theme	NPS Concern	Suggested Ways to Address Concern
Surface Water Drainage, Non-Point Source Pollution	The quality of the groundwater entering Kaloko-Honokōhau National Historic Park should be preserved	"The EIS should contain a thorough and rigorous analysis of potential impacts, direct and cumulative, to groundwater and groundwater-fed ecosystems." "A full analysis if drainage construction techniques beyond what are required by the county and state, such as filtered drainage systems appropriately and specifically engineered to be effective in Kona's arid, low soil environment to reduce non-point source pollution to the groundwater and marine waters."
Water System	Water conservation measures need to be incorporated into the Plan	"A quantitative analysis if the potential changes to groundwater flow and quality within the aquifer system must be made to identify the impacts on the National Park inland and nearshore marine waters"
Wastewater System	Proposed methods for dealing with wastewater treatment, effluent, and their direct and cumulative impacts need to be analyzed	"Septic Systems should not be considered for this proposed project." "Methods for disposal of medical wastes and prevention of accidental releases of hazardous wastes from the medical facilities should be described in more detail."
Roadway System and Traffic	Address significant additional noise and traffic on Queen Ka'ahumanu and at access point to the National Park and Park headquarters	"The EIS should analyze the effects of the increase in traffic, including direct, indirect, and cumulative impacts to visitors accessing the National Park and the measures planned to alleviate traffic congestion, including a detailed discussion of the proposed interchange connecting Kaloko Makai with the Queen Ka'ahumanu Highway."

Theme	NPS Concern	Suggested Ways to Address Concern
Noise	An analysis of direct and cumulative increased noise generated y the project needs to be conducted (during construction and at full build-out phases)	"Address the soundscape within the National Park."
Air Quality	Air quality and its effect on human health needs to be addressed	"The EIS should discuss how new sources will be controlled and appropriate mitigations for improving post-construction air quality."
Visual Resources	Mitigate adverse changes to viewshed, night sky, topography and vegetation within the Project area	"The EIS should include a viewshed analysis form the National Park looking mauka to examine and analyze direct and cumulative impacts to cultural landscape, park viewshed, night sky and a description of how these impacts will be mitigated." "Include a more detailed analysis of building designs that will minimize viewshed impacts and blend development into the landscape, as well as including a discussion of appropriate plantings to reduce those visual impacts."
Archaeological and Cultural Resources	Should include the Kaloko-Honokōhau National Historic Landmark designation in Project's listing of archaeological and cultural resources	"There should be discussion in the EIS regarding early consultation and engagement with lineal descendants and the Native Hawaiian community specifically about the development plans and archaeological/cultural resources, cultural landscape, and potential places of significance."
Preservation/ Open Space and Connectivity to the National Park	Preserving and fostering connectivity between the National Park and the Ala Kahakai National Historic Trail	"The EISPN discusses preserving and protecting archaeological sites, the Road to the Sea, establishing open space and preserving coastal dryland forest. These are integral parts of the cultural landscape of the Park and the ahupua'a."
Impacts to Coastal and Recreational Resources	An analysis of the impacts to coastal and recreational resources because of this projects should be conducted	"The EIS should analyze direct and cumulative effects of 5,000 additional resident families utilizing the National Park and its coastal resources. This analysis should include direct, indirect and cumulative impacts resulting from recreational uses on the National Park's law enforcement and visitor services, the park's future Cultural Live-in Center, archaeological sites, fisheries, fish, coral and protected species inhabiting near-shore waters and beaches."
Contextual Issues, Cumulative Impacts	Existing and proposed developments around the Project area should be taken into account	"Cumulative, direct and indirect impacts that will affect Park resources, visitors and those engages in traditional and cultural practices, particularly traffic, noise, air pollution, night sky light pollution, mauka viewshed, increased park visitation, coastal recreational use, and the quality and quantity of ground water resources."

APPENDIX A: KALOKO MAKAI INTERVIEW GUIDE

Interviewee Name:
Affiliation:
Date:
Method of Interview:

Aloha and thank you for taking the time to answer these questions. We are independent consultants, retained but not employed by Stanford Carr Development, LLC, the proposed developers of Kaloko Makai in the Kohanaiki and Kaloko ahupua'a of North Kona, County of Hawai'i. We're conducting a social impact study to be included in the development's Environmental Impact Statement, which is being prepared by Wilson Okamoto Corporation.

As part of this study, we are interviewing a cross-section of community leaders from West Hawai'i. We intend to print the names and affiliations of the people we interview, but not quote anyone by name. We will summarize the general themes, issues, and concerns, but we will not tell the developers or anyone else who said what. We are not the developer's representative, and we're better able to ask questions than to answer them. If you have any questions, please write them down. The developer has retained a representative, Peter Young, and we can give you his contact information if you'd like to follow up with him.

General West Hawai'i Questions

1. Please tell me a little about yourself, the organizations you're involved in. What are the main community issues you and these groups have recently been focusing on?

2. What do people most value about living here, what's going well, what makes it desirable or different from the rest of the state?

3. And what are the major problems for West Hawai'i, the things that people are most concerned about these days? What needs or complaints do you know about?

Project-Specific Questions

4. What, if anything, have you heard about the Kaloko Makai project? Is this proposal pretty well-known to the people in your organization(s), or not?

5. Is the Stanford Carr Development company known in Kona? Does it have any particular image?

6. From what you (know of the project / can see in the project description), what do you think are potentially the most positive things about the project – ways it could be good for West Hawai'i or for the people in your group(s)?

7. And what do you think are potential problems – ways it could be bad for West Hawai'i or for the people in your group(s)?

8. Right now the major hospitals for West Hawai'i are the Kona Community Hospital (94 beds) 11 miles south of the Project and the North Hawai'i Community Hospital in Waimea (50 beds).

   a. Do you think these facilities are adequate to cover the growth from this proposal and other projects in West Hawai'i?

   b. This Kaloko Makai project includes a site for a new regional hospital. Does this general location seem a good one for that purpose?

9. Are you aware of the Kona Community Development Plan (CDP)? Were you involved in the community outreach efforts which led to the drafting of the plan?

10. The project's EISPN states: "*The proposed project is identified as a Neighborhood Transit Oriented Development (TOD) in the Kona Community Development Plan. Kaloko Makai will be setting aside land for development of an urgent care medical facility, as well as land for a future hospital. A hospital developer/operator is being pursued. When a hospital commits to locating a hospital at Kaloko Makai, the TOD will automatically be designated as a Regional Center TOD. Therefore, Kaloko Makai is being conceptually designed on the assumption that Kaloko Makai will be a Regional TOD*".

    A Regional Center could have a much larger land area and higher densities. The Kona CDP now targets four Regional Centers for the area from Keauhou to Keāhole; with the hospital, Kaloko Makai would become a 5th[26].

    a. Do you feel the Kona CDP's placement of a TOD community at Kaloko Makai is appropriate?

    b. Does it matter to you whether the TOD planned at Kaloko Makai is a Neighborhood or Regional Center TOD with a hospital? Why?

11. The developer says the first things to be constructed would be the roads and basic infrastructure, along with "Village I" just above the Queen Ka'ahumanu Highway.

[26] Pages 4-128 and 4-129 of the Kona CDP have language about hospitals and Regional status: "To encourage the private sector to negotiate a site for the hospital, the TOD in which the hospital decides to locate within shall be automatically designated a Regional Center TOD if the Official Kona Land Use Map has designated it as a Neighborhood TOD. As a Regional Center TOD, there would be incentives for medical offices and other hospital-related businesses to develop in the vicinity"

Everything else would be built to respond to residential market demand, probably over a roughly 30-year period. Does this strike you as a reasonable phasing approach?

12. The largest portion of this project is the construction of 5,000 new single- and multi-family residential units at low- and medium-densities over about 30 years. Please tell me a little about what people in West Hawai'i are saying about the need for housing these days.

    a. First, do you believe there really is a need among the existing workforce?

    b. What type of housing is needed, and what do you think will determine whether this project does a good job of meeting actual need?

    c. Please review the available information about the developer's intention to develop "affordable housing" as part of the project.

       - Overall, does this seem like a good approach? Does it seem any better or worse than other developers' approaches to affordable housing?

       - What do you think is the better way to mix affordable units into an overall development – mix them up with the market rate units, or have some concentrated pockets, which could make them even more affordable but less well integrated?

    d. Can you think of other recent housing developments in West Hawai'i that generated either positive or negative impacts? (If so, what made them good or bad, what were the "lessons learned" for residential development here)?

13. Plans include roughly 140 acres of roads and utility infrastructure to support the development. Do you have any comments regarding how the development might impact the current transportation and infrastructure needs of the area?

14. You'll note this project includes a segment of the long-planned Mid-Level Road that would provide an alternate to the Queen Ka'ahumanu Highway for getting from Kailua to the airport.

    a. We'd like to know if you have any questions or advice to the developer about the importance of getting this built.

    b. Do you see any other opportunities for this project to help with solving traffic issues, either from the project itself or from general growth?

15. The development plans also include retail, commercial and high tech business development. Do you believe these proposed uses seem appropriate – any thoughts or issues on those particular parts of the proposal?

16. Kaloko Makai plans include two elementary schools and a middle school. Do you believe those plans mesh with existing and future community education needs?

17. Finally, the project includes a possible historic trail, 65 acres of interconnected park space, and 150 acres of dryland forest open space area

    a. Currently, what current similar areas are utilized by the community?

    b. Are there any particular community needs you think could be met with the development of these new areas?

    c. What sort of facilities should be provided?

18. If this project could be changed in just one way to make it better for West Hawai'i, what would that change be?

19. know if we can talk to everyone in West Hawai'i, but what other groups do you think would be particularly affected by, or interested in, this project? Who else should we make an effort to contact?

Mahalo for your time! Do you have any questions?

APPENDIX B: KALOKO MAKAI PROJECT DESCRIPTION

Size and Location: About 1,142 acres, extending mauka from Queen Ka'ahumanu Highway. The Queen Ka'ahumanu portion is located just north of the existing Kaloko Industrial Park. Hina Lani St. forms the southern (Kailua-side) border of the lower part of the property, but the upper part includes land on both sides of Hina Lani.

Current Use and Land Use Designations: Vacant and undeveloped. County General Plan – Urban Expansion and Conservation. Keāhole to Kailua Development Plan – Urban Expansion, Residential Village, and Golf Course. (*The current General Plan "Conservation" designation was for a once-planned golf course that would be deleted under the new plan; the developer will ask the County for Urban designation of the former golf course land after State Land Use approval.*) Kona Community Development Plan (CDP) indicates the general Kaloko Makai area as one of the designated "villages" for transit-oriented development.

State Land Use now Conservation, Agricultural, and Urban – request is to change about 224.5 acres from Conservation to Urban and 728 acres from Agricultural to Urban. (The State Urban designation would follow the County's Kona CDP designation as an urban area.) A 150-acre dryland forest preserve will be created. An EIS is being prepared.

Development Concept/Phasing: Consistent with the Kona CDP, Master-planned residential community, with supporting commercial, educational, recreational, open space, and related infrastructure. Primarily a residential development, with some business/commercial job centers. To be developed in three phases (or "villages") over an estimated 28 years. First homes by 2015.

Key Components:

- Residential - At full development about 5,000 new single- and multi-family residential units at low (up to 3 units per acre) and medium (up to 20 units per acre) densities.
- Commercial – About 120 acres in various locations. Largest would be a business park that may potentially include Scientific Research & Development facilities, retail, and a regional hospital along the Mid-Level Road. Mixed-use areas of the project are designed to include residential and commercial uses within close proximity of each other (this may include affordable residential on top of a variable commercial component).
- Preservation / Open Space / Recreation – In addition to the dryland forest (150 acres of preserved forest and natural habitat), the project will preserve a historic trail which is commonly referred to as the *Road to the Sea*. While the boundaries of this trail (within the Kaloko Makai property) have yet been determined, we are sure that the trail originates in the mid-section of the property just east (makai) of Kaloko Makai (in the site, properly named Kaloko Heights) and meanders down through the KM parcel. A series of archaeological outcroppings have also been noted in our Archaeological Inventory Report. Depending on the nature of each archaeological site buffer zones will be provided accordingly.
- Facilities and Roads – Land set aside for elementary and middle schools. Active parks and recreation areas. The proposed Mid-Level Road would cut across the project.

Estimated Housing Prices and Types *(Current Developer Assumptions)*:

- "Affordable" Component – Will be 20% of units (about 1,000), targeting residents with income levels between 60%-140% of area median income. Based on 2007 HUD numbers, that would include at least some units for rental to 3-person low-income families at $972/month and for sale at $152,600 (2007 numbers). Final mix of affordable not yet known.
- Market Component – A wide range of products, in today's dollars from mid to high $200,000's up to $1,000,000. The target market is the local rather than the offshore buyer. Overall, the project is intended to respond to already-planned economic growth rather to generate more of it

For a more complete description, you can download the EIS Preparation Notice from:
http://oeqc.doh.hawaii.gov/Shared%20Documents/EA_and_EIS_Online_Library/Hawaii/2010s/2010-09-23-HA-EISPN-Kaloko-Makai.pdf.

[**IN FINAL PDF, ELIMINATE THIS PAGE AND INSERT THE PDF'S OF TWO MAPS SHARED AS PART OF PROJECT DESCRIPTION!]

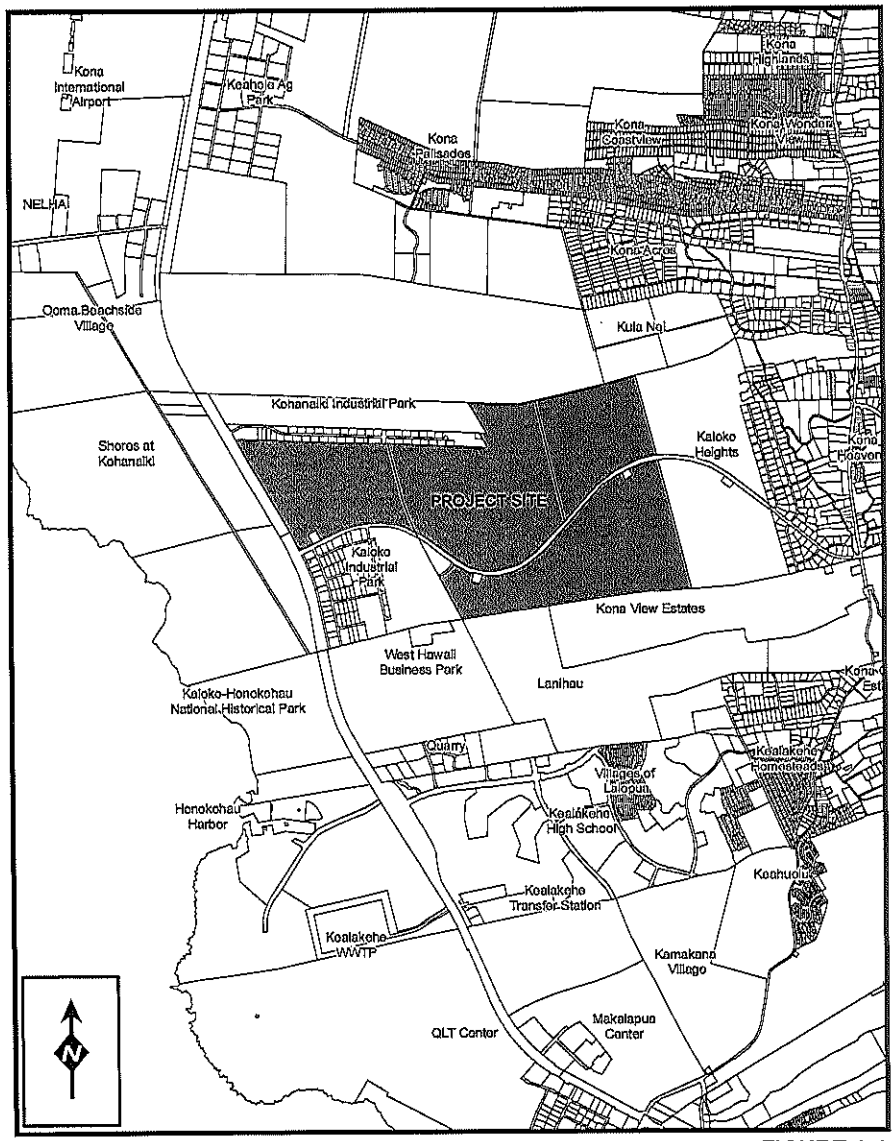
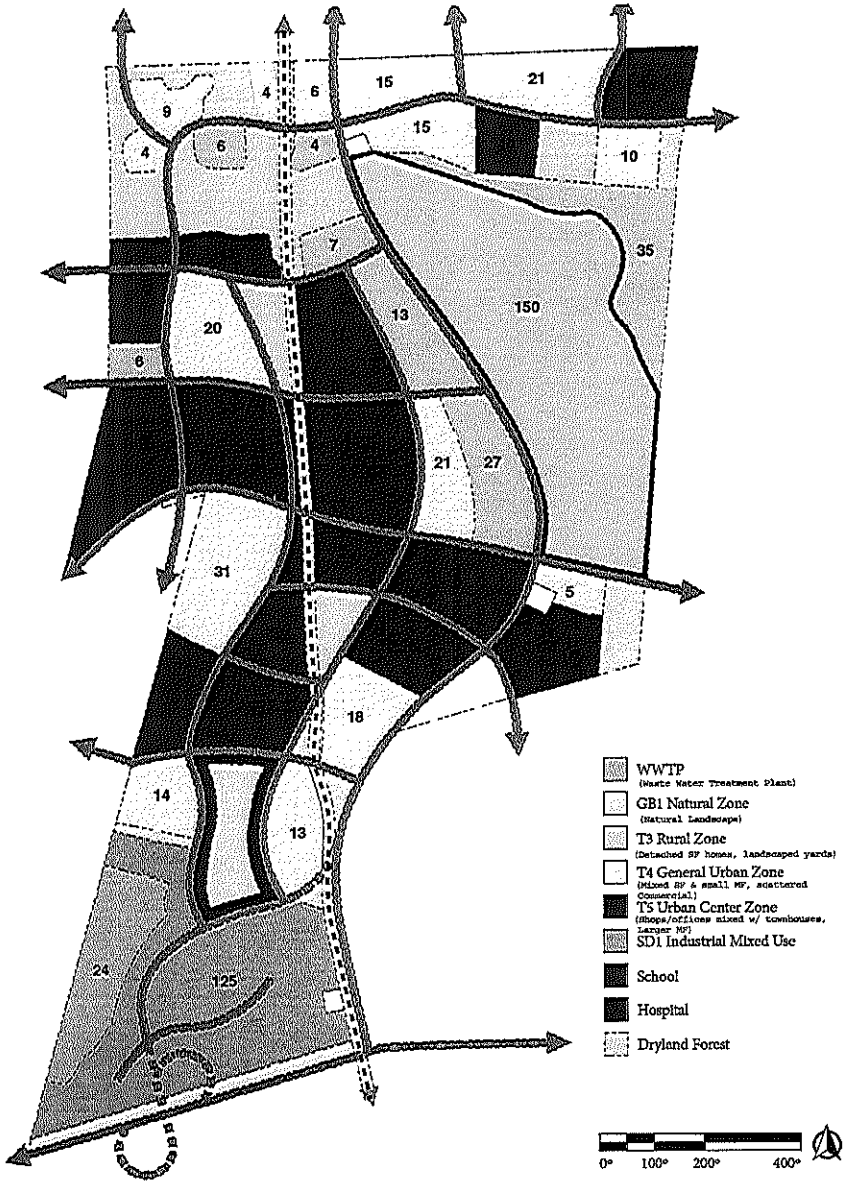


FIGURE 1-4
Existing and Proposed Uses Within the Vicinity of the Project Site
Kaloko Makai



Kaloko Makai Village Plan

°DAEDALUS DESIGN Confidental

Transect Zone Allocation

Scale 1"= 250'

J•M•K JOHN M. KNOX & ASSOCIATES, INC.

KALOKO MAKAI SOCIAL IMPACT ASSESSMENT

Volume 2: Housing Issues

June 9, 2011

Prepared for:
Stanford Carr Development, LLC.

Prepared by:
John M. Knox & Associates, Inc.
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FOREWORD

John M. Knox & Associates was engaged to prepare a social impact assessment of the proposed Kaloko Makai mixed-use commercial and residential development in Kona. In accord with Kona Community Plan principles of providing housing choices, recreation opportunities, directing growth patterns towards compact villages and encouraging a diverse and vibrant economy, Stanford Carr Development proposes a 1,142-acre development with a strong emphasis on residential development.

The work is presented in three volumes:

1. Volume 1 presents background socio-economic conditions and results of a community interview process to surface key issues.

2. The current Volume 2 is an analysis of housing issues, prepared in part by subcontractor Tom Dinell (Dinell Associates). Mr. Dinell is Emeritus Professor in the University of Hawai'i Mānoa's Dept. of Urban and Regional Planning, teaching courses on housing there.

3. Volume 3 contains results of a 2009 "North Kona Community Planning Survey" that focused on awareness of the new Kona Community Development Plan (CDP) and extent of agreement with key element relevant to the proposed project.

SUMMARY AND ANALYSIS OF VOLUME 2 RESULTS

Chapter 1: The Policy Framework and the Kaloko Makai Project

Chapter 1 demonstrates that there is a demand for the type and quantity of housing that the Kaloko Makai Project will provide, especially in terms of affordable housing. The County policy documents – the General Plan, the Kona Community Development Plan, and the other Hawai'i County ordinances and rules relating to housing – describe this demand in general terms and the Market Assessment for Kaloko Makai, prepared by Mikiko Corporation, documents this demand as do the data presented in Chapter 2 of this Volume.

Chapter 1 also shows that the proposed Kaloko Makai Project is consistent with and implements the County General Plan, the Kona Community Development Plan, and the Village Development Guidelines. There is a close fit between these plans and guidelines on the one hand and the Kaloko Makai Project, as described in the Environmental Assessment/ Environmental Impact Statement Notice (September 2010), on the other.

The General Plan goals for housing do a good job of describing the Kaloko Makai Project – i.e., (1) constructing safe, sanitary, and livable housing for the residents of Hawai'i County; (2) providing a diversity of housing that allows a variety of choices; (3) creates a viable community with affordable rental and fee-simple housing in (4) a variety of sizes to satisfactorily accommodate the needs and desires of families and individuals; (5) ensures availability to all persons regardless of age, sex, marital status, ethnic background, and income, (6) in reasonable proximity to employment centers, while simultaneously (7) encouraging and expanding home ownership opportunities for residents.

The Kona Community Development Plan (CDP) specifies that the master plan for a TOD (transit oriented development) is to (1) promote transit-oriented and pedestrian-oriented development, increase transit use to manage traffic congestion; (2) encourage mixed-use, compact development that is pedestrian in scale and sensitive to environmental characteristics of the land and facilitate the efficient use of public services; (3) have residences, shopping, employment, and recreational uses located within close proximity of each other and efficiently organized to provide for the daily needs of the residents; (4) provide for a range of housing types and affordability within pedestrian-oriented, human-scale neighborhoods; (5) incorporate natural features, open space and cultural features; (6) provide efficient circulation systems for pedestrians, non-motorized vehicles, and motorists that serve to functionally and physically integrate the various land use activities; and (7) promote strong neighborhood identity and focus.

The proposed Kaloko Makai Project is designed to successfully meet each of the Kona CDP objectives. For example the inclusion of the Dryland Forest and the Historic Trail speak specifically to incorporating natural features, open space, and cultural features.

The Village Design Guidelines specify that TOD villages (1) are to be compact, pedestrian-oriented and mixed use; (2) that the ordinary activities of daily living are to occur within walking distance of most dwellings, allowing independence for those who do not drive; (3) that interconnected networks of transportation corridors are to be designed to disperse traffic and reduce the length of automobile trips; (4) that within neighborhoods, a range of housing types and price levels are to be provided to accommodate diverse ages and incomes; (5) that appropriate building densities and land uses are to be provided within walking distance of transit stops; (6) that civic, institutional, and commercial activities are to impart a focused town center and gathering place; (7) that schools are to be sized and located to enable children to walk or bicycle to them; (8) that a range of open space including parks, squares, and playgrounds are to be distributed within neighborhoods and villages; and (9) that the growth of each villages stays within a defined edge and thereby helps to establish a compact sense of place.

The requirements set forth in the Village Design Guidelines also do a good job of describing the plan for the Kaloko Makai Project. The schools, for example, are located so children can walk or bike to them. The walkability of the Project will vastly reduce the need for short vehicle trips. There is a range of open space in each village and all the villages have defined edges.

Chapter 2: Data on Social Issues Relating to Affordable Housing

In response to the frequent community concerns (as outlined in Vol. 1) about social impacts of high housing costs – particularly the sense that "local" residents are inequitably affected and often cannot qualify for officially designated "affordable" housing under HUD/County guidelines – we analyzed Census data on ethnic differences in housing outcomes for the Big Island and West Hawai'i in Chapter 2. (Ethnicity is used as a proxy for newcomer/local, as the great majority of "Whites" were <u>not</u> born in Hawai'i, while the great majority of Asians, Native Hawaiians, and Mixed Race population <u>were</u>.) Among the conclusions of the analysis:

- All groups – newcomer/longtime residents or ethnic/racial groups – face serious affordability issues in regard to housing in West Hawai'i (especially North Kona). Whites tend to pay more for housing in West Hawai'i and islandwide, even in areas where their average incomes are not higher than those for other groups.

- Native Hawaiians (and perhaps Filipinos) are particularly challenged in West Hawai'i due to lower overall incomes that reflect differences in overall education, age, and family structure (e.g., single parents). There is no evidence of deliberate discrimination, but these differences do result in unequal housing outcomes.

- "Affordable housing" guidelines tend to be harder for West Hawai'i residents to meet than for people elsewhere on the island for the perhaps ironic reason that incomes are higher there. These guidelines are based on the principle of median incomes for various family sizes, and the very usage of the median (the "middle point" in range of incomes) means that substantial percentages will fall below the median cut-off.

- Groups such as Native Hawaiians have a sort of "advantage" in meeting affordable-housing guidelines because of lower average incomes. But this "advantage" tends to be reversed by higher average household sizes, which means they must earn more to qualify in order to pay for larger homes. So it is in a sense true that County guidelines present more barriers to "local" qualification, but only because they reflect the underlying economic reality that larger homes cost more.

Ultimately, though, the social challenges facing West Hawai'i will probably have less to do with the fairness of "affordable housing" guidelines than with the soaring prices of market housing. The social impact of the Kaloko Makai Project will be positive to the extent that it succeeds in the goal of providing more affordable market housing to working families – a goal that would likely be achieved by greater densities consistent with the Kona Community Development Plan.

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1. THE POLICY FRAMEWORK AND THE KALOKO MAKAI PROJECT

This chapter describes both the proposed Kaloko Makai Project and the environment in which it is being developed and implemented. The County's policy framework – specifically its planning goals and objectives and the processes for meeting them – are set forth in some detail. Particular attention is paid to the Kona Community Development Plan and the accompanying Village Design Guidelines. The key conclusion from this chapter is that the Kaloko Makai Project as proposed furthers the accomplishment of these goals and objectives.

1.1 The Need for Housing in North Kona

Volume 1 of this study provides data on the general issue of lack of affordable housing and in West Hawai'i as a whole. Additionally, the Market Assessment for Kaloko Makai, prepared by Mikiko Corporation, documents the need for housing in North Kona in the time period 2010-2040.[1] Just a few highlights from that report will serve to indicate both the quantitative need for housing and the changing nature of the population to be served:

- The projected Hawai'i Island population increase between 2010 and 2040 is slightly more than100,000 people, or a 55% increase.
- As of 2010, the Competitive Residential Market Area (CRMA, defined as North Kona Census Tract 215.01and South Kohala Census Tract 217.01) provided 23% of employment positions on the island while at the same time housing only about 12% of the Island population.
- Population in the CRMA will grow at about 3.8% per year in the 2010-2040 time period.
- There will be an increasing concentration of households in the older age brackets.
- Average household size will continue to decrease.
- There will be a need for 17,600 new housing units in the CRMA during the next 30 years (2010-2040).

1.2 The Current Kaloko Makai Proposal with Respect to Housing[2]

What is being proposed is a residential mixed-use development on approximately 1,142 acres of undeveloped land in North Kona. It will include at full build-out up to 5,000

[1] Mikiko Corporation, Market Assessment for Kaloko Makai, Final Draft Report prepared for Stanford Carr Development Corporation

[2] See Wilson Okamoto Corporation, Environmental Assessment/Environmental Impact Statement preparation Notice Kaloko Makai, Kaloko and Kohanaiki, North Kona, Island of Hawai'i, Prepared for SCD-TSA Kaloko Makai, LLC, September 2010, for further details about the conceptual plans for the Kaloko Makai Project, pages 1-1 through 2-9.

residential units, both single-family and multi-family, with densities varying from three to 20 units per acre. The Project is to be developed in three phases or villages over an estimated 28 years.

This master-planned, mixed-use Project includes land devoted to centralized and neighborhood commercial and light industrial uses, two elementary schools, a middle school, a medical facility, parks, trails, open space, including a 150-acre dryland forest, and associated infrastructure.

The proposed Ane Keohokalole Highway will run through the Project. Kaloko Makai has been designated a Neighborhood Transit Oriented Development (TOD) in the Kona Community Development Plan (CDP). Kaloko Makai would become a Regional Center TOD once a hospital commits to the Project.

A major historic trail, which will be restored, runs through the Project in a mauka-makai direction.

The conceptual plans for the Project emphasize: (1) walkable villages, each with its own distinctive core; (2) pedestrian interconnectivity along pedestrian-scaled, tree-lined streets to neighborhood commercial centers and to neighboring villages; (3) front porches and rear lanais designed to facilitate neighborly interaction and indoor-outdoor living; and (4) a wide variety of housing options to provide living opportunities for a varied range of households of differing economic means. The Project will provide affordable housing that will more than adequately meet the County's affordable housing requirements in a diverse number of ways that will assure that there will be no affordable housing ghetto.

1.3 The County General Plan as Regards Housing

The County of Hawai'i General Plan[3] was adopted by ordinance in February 2005 and amended in December 2006. It "is the policy document for the long range development of the Island of Hawai'i."[4] It provides the planning framework for the community development plans, which are subsequently prepared for specific geographical districts such as Kona, as well as the Capital Improvement Program, the functional plans, e.g., sewage/drainage, and area improvement plans, e.g., downtown Hilo. The community development plans conform to the General Plan but are much more detailed and specific than the latter. In essence the community development plan implements the General Plan in a designated geographical area.

[3] See Section 9, Housing, and Sections 14, Land Use, especially Sections 14.5, Multiple Residential, and14.6, Single-Family Residential, in the County of Hawai'i, General Plan, February 2005 as amended in December 2006, online at <http://www.hawaii-county.com/la/gp/GP2005Amend%2012-2006%2005-2007%20and%20Ord%2009-161.pdf>.
[4] *Ibid.* p. 1-1.

Housing and Land Use are two of the many elements addressed in the General Plan. The other elements are: Economic, Energy, Environmental Quality, Flooding and Other Natural Hazards, Historic Sites, Natural Beauty, Natural Resources and Shoreline, Public Facilities, Public Utilities, Recreation, and Transportation.

The General Plan perceives housing as addressing much more than a person's need for shelter. "(A)dequate housing is one of the primary factors that provides a person a sense of satisfaction and well-being".[5] The Plan stresses that when the cost of land, land improvements, and home construction increase faster than personal income, many persons are prevented from purchasing homes (or, one could add, renting adequate quarters). This gives rise to one of the County's major concerns, which is affordable housing. This concern led to the establishment of the Hawai'i County Housing Agency and the Office of Housing and Community Development in the 1970s and the adoption of an affordable housing policy in 1998.[6]

The General Plan states:[7]

> In existing urban areas, the supply of readily available housing and residential zoned land is nearing a point where flexibility in choice of location and price will be limited and will contribute to rising costs of housing unless additional and alternative areas are made available for residential development.

Among the goals put forth in the General Plan that relate to the Kaloko Makai Project are the following:[8]

a. Attain safe, sanitary, and livable housing for the resident of the County of Hawai'i
b. Attain a diversity of socio-economic housing mix;
c. Maintain a housing supply that allows a variety of choices;
d. Create viable communities with affordable housing and suitable living environments;
e. Seek sufficient production of new affordable and rental and fee-simple housing in the County in a variety of sizes to satisfactorily accommodate the needs and desires of families and individuals;
f. Ensure that housing is available to all persons regardless of age, sex, marital status, ethnic background, and income;
g. Make affordable housing available in reasonable proximity to employment centers; and
h. Encourage and expand home ownership opportunities for residents.

The General Plan, after noting the rapid increase in population in the North Kona district, outlines two courses of action that relate closely to the Kaloko Makai Project, namely:[9]

[5] *Ibid.* p. 9-1.
[6] *Ibid.* pp. 9-2 and 9-3.
[7] *Ibid.* p. 9-5.
[8] *Ibid.* p. 9-10.
[9] *Ibid.* p. 9-26.

a. Encourage the use of innovative types of housing developments, such as cluster and planned unit developments, that take advantage of the steep topographic conditions; and
b. Increase affordable housing opportunities in the Kailua-Kona area.

Multiple Residential and Single-Family Residential are two sub-sections of the Land Use Section of the Hawai'i County General Plan. The goals in the multiple residential section address: (1) providing "developments that maximize convenience of its (sic) occupants"; and (2) providing "suitable environments that accommodate the physical, social and economic needs of island residents".[10] In the Standards section, the Plan specifies that "Areas shall be located in such a manner that traffic generated by high density developments will not be required to travel through traffic areas of lesser density en route to principal community facilities".[11] The Plan goes on to point out that the Kona district has over 1,000 acres for multiple residential use, but some of the areas so zoned lack basic infrastructure essential for development.[12]

The goals in the Single-Family Residential Section emphasize maximizing "choices of single-family residential lots or housing for residents of the County" and providing "single-family residential areas conveniently located to public and private services, shopping, other community activities and convenient access to employment centers that takes natural beauty into consideration".[13] In terms of courses of action, the Plan encourages: (1) concentration of residential structures to avoid strip residential development"; and (2) "the use of more innovative types of housing developments, such as zones of mix and cluster and planned unit developments".[14]

In sum, the Kaloko Makai Project is thoroughly in synch with the goals and courses of action for housing as put forth in the County of Hawai'i General Plan 2005 as amended.

1.4 The Kona Community Development Plan as Regards Housing

The Kona Community Development Plan (Kona CDP), which includes both North and South Kona, was enacted by ordinance on September 25, 2008. It was adopted pursuant to and in accordance with the Hawai'i County General Plan 2005 as amended. If a provision of the Kona CDP and a prior adopted ordinance are in conflict, the Kona CDP governs.[15] The Kona CDP includes goals, objectives, policies, and actions for transportation, land use, environmental resources, cultural resources, housing, public

[10] *Ibid.* p.14-42.
[11] *Ibid.*
[12] *Ibid.* p. 14-45.
[13] *Ibid.* p. 14-47.
[14] *Ibid.* p.14-51.
[15] See County of Hawai'i Planning Department, Kona Community Development Plan; Mapping Kona's Future. Prepared by Wilson Okamoto Corporation, September 2008; at < http://www.hawaiicountycdp.info/north-and-south-kona-cdp/cdp-final-drafts/Final%20KCDP_Sept%202008_text.pdf/view>

facilities, infrastructure, and services, energy, and economic development as well as an action plan, a monitoring plan, and introductory sections.

The three primary sections that bear on the Kaloko Makai Project, but not the only ones, are land use and housing and Attachment B, Village Design Guidelines. The Kona CDP sets forth eight guiding principles, two of which are directly applicable to Kaloko Makai:[16] (1) "provide housing choices"; and (2) "direct future growth patterns toward compact villages, preserving Kona's rural, diverse, and historical character".

With respect to housing choices, the Kona CDP states:[17]

> Future growth should offer a broad range of mixed housing choices with a variety of types and price ranges that are affordable and available in close proximity to places of work. They should also accommodate populations with special needs, including seniors, disabled persons, and the homeless.

With respect to urban villages, the Kona CDP states[18]:

> The majority of future growth should be directed north of Kailua, with some future growth in the Kailua to Keauhou area, in the form of compact villages that offer increased density and mixture of homes, shops, and places to work.

1.4.1 The Land Use Element

Kaloko Makai Village is identified in the Kona CDP as a Neighborhood TOD (Transit Oriented Development).[19] If, as anticipated, a medical center becomes part of Kaloko Makai, then the Regional Center designation would apply. A neighborhood village is defined as follows:[20]

> Neighborhood Village Core Areas are intended for predominately residential, public/civic uses, or small-scale neighborhood-oriented commercial uses. The Core's commercial uses are of a small scale and are intended to serve the needs of the Village residents. Neighborhood Village Core Areas shall be designed around a Neighborhood Center. Land uses include recreational space, small-scale public/civic uses, neighborhood oriented retail uses, and mixed-use.

A regional center is described as follows:[21]

> Regional centers are intended for mixed use and higher density residential, retail, commercial, employment, and/or regional one-of-a kind facilities, such as major civic, medical, education, and entertainment facilities. Regional centers shall be

[16] *Ibid.* p. 3-1 thru 3-3..
[17] *Ibid.*
[18] *Ibid.*
[19] *Ibid.* p4-41.
[20] *Ibid.* p. 4-40
[21] *Ibid.*

designed around a Commercial Center, which is the focus for the Village and designed to encourage pedestrian activity.

In addition to the data required for Project District Rezoning Application, the application shall include the following:[22]

a. Master Plan. To the extent practicable, the master plan shall conform with the Village Design Guidelines ... and at a minimum address:

   i. Mix of permitted uses and density;
   ii. Transportation systems including street layout and standards, transit routes and facilities, and bike and pedestrian pathways;
   iii. Village center public facilities and financing;
   iv. Infrastructure requirements, financing, and timing;
   v. Neighborhood park and public space standards;
   vi. Phasing plan;
   vii. Calculation and treatment of density transfer area; and
   viii. Planning process, including extent of consultation with the Design Center.

b. An environmental report meeting the requirements of HRS Chapter 343.

Incentives for following this process include expedited review by the Planning Director and the Planning Commission, concurrent processing of the environmental review document and the state land use boundary amendment by the County, and "the rebuttable presumption that the project furthers the intent of Chapter 25, the Zoning Code, and is consistent with goals, policies, and objectives of the County General Plan and the Kona CDP".[23] In addition, public financing shall pay for all of the costs of the major trunk transit route, a transit station, and a major park or plaza.[24]

The master plan for a TOD project is to further the intent of the Village Design Guideline, namely:[25]

1. Promote transit-oriented and pedestrian-oriented development, to increase transit use, to manage traffic congestion,
2. Encourage mixed-use, compact development that is pedestrian in scale and sensitive to environmental characteristics of the land, and facilitates the efficient use of public services;
3. Have residences, shopping, employment, and recreational uses located within close proximity with each other and efficiently organized to provide for the daily needs of the residents;
4. Provide for a range of housing types and affordability within pedestrian-oriented, human-scale neighborhoods;
5. Incorporate natural features, open space and cultural features;

[22] *Ibid.* pp.42-43.
[23] *Ibid.* p. 4-43.
[24] *Ibid.* p. 4-45.
[25] *Ibid.* p. 4-44.

6. Provide efficient circulation systems for pedestrians, non-motorized vehicles, and motorists that serve to functionally and physically integrate the various land use activities; and
7. Promote strong neighborhood identity and focus.

1.4.2 The Housing Element

The consequences of a lack of affordable housing are multiple: (1) people who want to move to a new unit are unable to do so; (2) some families are forced to live doubled-up; (3) some people become homeless; (4) young families move elsewhere where they can afford a home, leading to a shortage of workers; and (5) workers commute long distances, e.g., from Ka'ū, to their jobs in Kona. These consequences impact not only households earning less than the median income, but also families with moderate income whose members provide essential community services, such as teachers and police officers.

There are County-wide programs already in place designed to stimulate the availability of affordable housing:[26] (1) affordable rental property tax incentives; (2) density bonuses for meeting the affordable housing requirement; (3) a homebuyer education program; and (4) the Hawai'i island Housing Trust, a 501(c)(3) non-profit corporation.[27]

The Kona CDP includes several elements in its housing strategy that are of particular relevance for the Kaloko Makai Project.[28] The Plan stresses the importance of accessory or 'ohana units as a means of increasing the supply of rental housing as well as providing a source of income for the property owner. Second, the plan emphasizes the importance that some of the affordable inventory be perpetually affordable. Third, the Plan emphasizes the importance of addressing the housing needs of the elderly and the disabled. As an incentive, additional credits are provided for meeting the needs of these two groups.

The affordable housing credits in the Kona CDP – which are somewhat more liberal than those provided Chapter 11, Hawai'i County Code (HCC) – are designed to encourage workforce housing for those earning 120% to 180% of median household income, the elderly, and the disabled, as shown in Table 1.1 below.[29] Credit is also granted for affordable live/work units. Chapter 11, HCC, Housing, provides a 10% density bonus for meeting the affordable housing requirement, which is 20% of the total units as specified in Section 11-4(b)(2) of Chapter 11. The Kona CDP adds "...a 1:1

[26] Ordinance 1138, which was signed by the Mayor on April 25, 2011, has amended the affordable housing requirements by specifying that: "1. A minimum of 20% of the required affordable housing unit credits [shall be] earned at one credit per unit (100% to 120% of median household income) or higher; 2. A minimum of 30% of the required affordable housing unit credits [shall be] earned at 1.5 credits per unit (80% to 100% of median household income) or higher; and 3. A minimum of 40% of the required affordable housing unit credits [shall be] earned at two credits per unit (80% and under of median household income)."
[27] *Ibid.* p. 4-84.
[28] *Ibid.* pp. 4-85, 4-88, and 4-89.
[29] *Ibid.* p. 4-93

density bonus over and beyond the 10% bonus in HCC Section 11-8 for each affordable housing unit that exceeds the affordable housing requirements, up to a maximum 30% density bonus."[30]

Accessory or 'ohana units are encouraged with the intent of increasing the supply of rental housing, "For TODs ..., any provisions in the Project District rezoning ordinance relating to accessory units may preempt the zoning code 'ohana dwelling provisions (HCC Chapter 25, Article 6, Division 3)."[31]

Table 1.1 Affordable Housing Credits

	Percentage of Median household income	Affordable Housing Credit per HCC Section 11-5	Elderly, Disabled, or Live-Work Unit Credits
Dwelling Unit	120-180% (proposed)	0.25	0.75
	120-140%	0.5	1.0
	100-120%	1.0	1.5
	80-100%	1.5	2.0
	80%	2.0	2.5
Rental Unit	80-100%	1.0	1.5
	60-80%	1.5	2.0
	60%	2.0	2.5

The Kona CDP is designed to maintain the stock of affordable housing units for a period of 40 years. The following restrictions apply during the resale-restricted period:[32]

> **1st 20 years:** The affordable units shall have a minimum 20-year controlled appreciation restriction (cost of improvements plus appreciation based on the Honolulu Consumer Price Index;
> **After 20 years:** The owner may sell the property at market value with a shared appreciation with the County or Kona Housing Non-Profit at 50%;
> **Right of First Refusal:** After 20 years, the Kona Housing Non-Profit shall have the right of first refusal to purchase the unit;
> **Owner-occupancy:** During the resale-restricted period, affordable units must remain owner-occupied or rented out by the owner at an affordable rate as certified by the County real property tax division pursuant to the affordable rent provisions in HCC Chapter 19.

Further, the Kona Housing Non-Profit or other non-profit established pursuant to the Kona CDP has the first right of refusal on 10% of the required affordable units.[33]

The Kaloko Makai project is in a position to provide the affordable housing units required by Chapter 11, HCC, and the Kona CDP and to utilize the bonus incentives established in those two legal documents.

[30] *Ibid.*
[31] *Ibid.*
[32] *Ibid.* p. 4-94.
[33] *Ibid.*

1.4.3 Village Design Guidelines

The Village Design Guidelines provide development standards for TOD villages. The standards are based on the national SmartCode and "calibrated" to fit the Kona CDP.[34] The SmartCode is a form-based code designed to result in compact, walkable villages. With respect to TOD villages, the intent is as follows (Capitalization is as in original document):[35]

a. That Villages and REGIONAL CENTERS be compact, pedestrian-oriented and MIXED USE.
b. That ordinary activities of daily living occur within walking distance of most dwellings, allowing independence to those who do not drive.
c. That interconnected networks of transportation corridors be designed to disperse traffic and reduce the length of automobile trips.
d. That within neighborhoods, a range of housing types and price levels be provided to accommodate diverse ages and incomes.
e. That appropriate building DENSITIES and land uses be provided within walking distance of transit stops.
f. That CIVIC, institutional, and COMMERCIAL activity impart a focused town center and gathering place.
g. That schools could be sized and located to enable children to walk or bicycle to them.
h. That a range of OPEN SPACE including parks, squares, and playgrounds should be distributed within neighborhoods and villages.
i. That the growth of the village stays within a defined edge and thereby helps to establish a compact sense of place.

No attempt will be made in this volume to summarize the multiple design provisions included in the Village Design Guidelines other than to highlight a few specific provisos and to call special attention to Article 3, Village Scale Plans – New Villages, and Article 5, Building Scale Plans.

The Guidelines state that: "ACCESSORY UNITS are not included in the density calculation to encourage this residential use."[36]

In speaking of building configuration, the Guidelines state: "One PRINCIPAL Building at the FRONTAGE and one ACCESSORY UNIT to the rear of the PRINCIPAL BUILDING may be built on each LOT as shown in Table 14c, and "Rear SETBACKS for ACCESSORY UNITS shall be a minimum of 12 feet measured from the centerline of the REAR ALLEY easement."[37] Further, "ACCESSORY UNITS may be of any size, not to exceed 900 sq. ft."[38] In Article 7, Definitions, however, an Accessory unit is defined as:

[34] The SmartCode, Version 9.0, authored by Andres Duany, Sandy Sorlen, and William Wright, is available fro the New Urban News at <http://newurbannetwork.com/tools/books/smartcode-version-9-and-manual>
[35] Village Design Guidelines, Attachment B, Kona Community Development Plan, September 2008, p. 3.
[36] *Ibid.* p.8.
[37] *Ibid.*, p. 22
[38] *Ibid.* p.23.

"...an Apartment not greater than 440 square feet sharing ownership and utility connections with a Principal Building".[39]

In speaking of parking and density calculations, the Guidelines specify: "ACCESSORY UNITS do not count toward DENSITY calculations". [40]

In addressing parking location standards, the Guidelines state: "Parking shall be accessed by REAR ALLEYS when such are available on the REGULATING MAPS".[41]

The villages as planned for the Kaloko Makai Project fit the standards for TOD villages as specified in the Guidelines. Further, the Guidelines specifically encourage the inclusion of accessory or 'ohana dwelling and the use of alleys for access to parking areas.

1.5 The Hawai'i County Ordinances Relating to Housing

Three Hawai'i County Ordinances immediately relate to housing: (1) Chapter 11, Housing, Article 1, Affordable Housing (there are no other articles in this chapter); (2) Chapter 25, Zoning; and (3) Chapter 19, Real Property Taxes, particularly as it relates to two property classes: affordable rental housing and homeowner.

Most of the affordable housing requirements, the manner in which the requirements can be satisfied, the density bonuses earned by meeting the affordable housing requirement, and the resale restrictions are specified in the Housing Section (4.5) of the Kona Community Development Plan. Since the Kona CDP was adopted by ordinance, it provisions supersede those specified in Chapter 25, Zoning, of the Hawai'i County Code. The one provision in Chapter 11 that is not replaced by provisions in the Housing Section of the Kona Community Development Plan specifies that the Office of Housing and Community Development (OHCD) shall: (1) determine the rental price for units of various sized annually; and (2) enter into an agreement with the developer assuring that the rental prices will be controlled for a period of at least 20 years.[42]

The provisions of the Kona CDP amend Chapter 25, Zoning, by defining TODs, establishing TOD floating zone project districts, adopting the Village Design Guideline, and requiring mandatory Design Center review of all master plans prepared for TOD floating zones.[43]

Article 6, Division 3 of Chapter 25, Zoning, Sections 25-6-30 through 25-6-39.7 govern 'Ohana Dwellings. The provisions relate to where and when (e.g., adequate public facilities to serve the unit) 'ohana units can be constructed and where they are

[39] *Ibid.* p. 27.
[40] *Ibid.* p. 24.
[41] *Ibid.* p. 25.
[42] Section 11-11 of the Hawai'i County Code (HCC).
[43] Actions LU-2.1a, LU-2.3a, ,LU-2.4a, LU2.5a, and LU-4.2a of the Kona CDP, pp 4-42 thru 4-50.

prohibited, the height limit, the minimum building site area and yard requirements, parking requirements, and the application and appeal process. These provisions may be superseded for TODs. The Kona CDP specifies that: "For TODs..., any provision in the Project District rezoning ordinance relating to accessory units may preempt the zoning code 'ohana dwelling provisions".[44]

Chapter 19, HCC, governs the Real Property Tax System on the Island of Hawai'i. The table below shows the nine property classes and the property tax rate per $1,000 of net taxable building and land for the period July 1, 2010 to June 30, 2011.[45]

Table 1.2 Hawai'i County Tax Rates, Fiscal Year July 1, 2010 to June 30, 2011

Property Class		Tax Rate Per $1,000 Net Taxable Land	Tax Rate Per $1,000 Net Taxable Land
0	Affordable Rental Housing	$5.55	$5.55
1	Residential	$9.10	$9.10
2	Apartment	$9.85	$9.85
3	Commercial	$9.10	$9.10
4	Industrial	$9.10	$9.10
5	Agricultural and Native Forest	$8.35	$8.35
6	Conservation	$9.85	$9.85
7	Hotel/resort	$9.85	$9.85
9	Homeowner	$5.55	$5.55

Note: Chapter 19, Article 11, Section 19-90 of the Hawai'i County Code provides that the tax rates to be set on or before June 20 preceding the tax year for which property tax revenues are to be raised.

The two classes that are of particular interest are "Affordable Rental Housing" and "Homeowner". For FY 2011, the tax rates per $1000 for affordable rental housing and for homeownership were set at approximately 61% of the residential rate and 56% of the apartment rate. The County Council is to establish the rates by resolution prior to June 20 of each year. If the Council does not do so, then the rates currently in effect continue for another year.[46]

To be placed in the homeowner class, the property owner must successfully qualify for a home exemption, which will reduce the net taxable value of his/her property, as discussed below. A housing unit qualifies for the affordable rental housing class if it meets the affordable housing qualifications. A new application for inclusion in this class must be filed annually. The owner of the property must submit sufficient documentation of the monthly rent, such as a signed lease, and the rent must be such as to qualify for the entire calendar year. One benefit of having one's rental unit in the Affordable Rental Housing Program is that the assessed value will not increase by more than 3% in any

[44] Kona CDP, Policy HSG-4.6: Accessory Units, p. 4-93.
[45] Hawai'i County Real Property Tax Office at <http://www.hawaiipropertytax.com/Forms/HtmlFrame.aspx?mode=Content/2003TAXRATES.htm>
[46] Section 19-90(b), HCC.

one year as long as the owner continues to own the property and reapplies annually to remain in the Program.[47]

To qualify for a home exemption, a person must own his/her home and live in it as his/her principal residence for a minimum of 200 days in a calendar year. This means that the owner has no other home exemption in any other jurisdiction, has the intent to create or maintain a principal home in Hawai'i County, and actually occupies the property. If a person leases a property for ten years or longer, lives in the house on the property, and the lease is recorded, then the lessee can qualify for a home exemption. Persons owning a unit in a multi-unit building can qualify for a home exemption. The home exemption reduces the assessed value of the home by $40,000. For persons ages 60 through 69, the exemption is $80,000. For those 70 years of age and older, the exemption is $100,000.[48]

1.6 The Hawai'i County Rules Relating to Housing

Rule 12, County of Hawai'i Planning Department, relates to 'Ohana Dwelling Units and Rule 15 to Project Districts. In one sense this section is irrelevant because the provisions of the Kona CDP supersede those of the Department of Planning's Rules of Practice and Procedure.

The provisions of the Kona CDP relating to defining TODs (Action LU-2.3a) – establishing TOD floating zone project districts (Action LU-2.4a) and the adoption of Village Design Guidelines (Action LU-2.5a) – render Rule 15 null and void as applied to the Kaloko Makai Project. Similarly, the provisions of the Kona CDP relating to TNDs (Traditional Neighborhood Developments) supersede Rule 15 as well.

The situation with respect to Rule 12, 'Ohana Dwelling Units, is somewhat different. The Kona CDP states that:

> Accessory ('ohana dwelling) units are encouraged in order to increase the supply of rentals. For TODs and TNDs, any provisions in the Project District rezoning ordinance relating to accessory units may preempt the zoning code 'ohana dwelling provisions (HCC Chapter 25, Article 6, Division 3).[49]

The Village Design Guidelines state:

> Provisions of this Code are activated by "shall" when required; "should" when recommended; and "may" when optional.[50]

[47] See Hawai'i County Real Property Tax Division, Department of Finance, "Affordable Rental Housing Program Information" at http://www.hawaipropertytax.com/Forms/pdffiles/Affordable%20Rental%20Housing%20Program%20Information%20(Mar%202011).pdf and Sections 19-53(h) and (i), HCC.
[48] Hawai'i County Real Property Tax Office at <http://www.hawaipropertytax.com/Forms/HtmlFrame.aspx?mode=Content/2003TAXRATES.htm>
[49] Kona CDP, Policy HSG-4.6, Accessory Units. p. 4-93.
[50] Section 1.2, Village Design Guidelines, p. 2

If the Kaloko Makai Floating Zone Project District and the subsequent Project District, subsequently adapted as an ordinance, contains provisions relating to 'Ohana units, they supersede the provisos of Division 3 of Chapter 25, HCC, 'Ohana Dwellings, and those of Rule 12, Department of Planning, 'Ohana Dwelling Units. Thus, it is very important for the Kaloko Makai Project to assure that a section of the Project District address the standards and requirements for 'ohana units within the Kaloko Makai Project. Rule 12 provides guidance in so doing. Section 12-4 lists the Department's concerns in terms of adequate public facilities, Section 12-7 in terms of number of 'ohana dwelling units per lot, Section 12-8 in terms of height, lot size, setback, and off-street parking, and Section 12-9 in terms of duplex units.[51]

1.7 The Hawai'i County Design Center

The Hawai'i County Design Center is seen in the Kona CDP as an instrument of innovation stimulating exposure to new idea and encouraging a willingness to try them.[52]

The Kona CDP envisions the Design Center as a place where people will: "... collaboratively learn and apply the best available practices, ... provide an inviting venue to brainstorm ideas among applicants, government officials, and community members."[53] In addition the Design Center exists to facilitate the permitting process: "For those applicants who use the services of the Design Center, a County employee will be assigned to assist in identifying the various permit requirements, suggest a work plan to coordinate the permit requirements, and follow through with various agencies to avoid delays."[54]

The Design Center is to work with landowners to encourage Project District rezoning applications that are consistent with the Village Design Guidelines.[55]

Policy LU-4.1 lists the objectives that the Design Center is to accomplish:[56]

1. To support and expedite the translation and implementation of the Kona CDP goals, objectives, policies, actions, and design guidelines as applied to proposed development projects;
2. To be a catalyst for creative excellence and innovation;
3. To foster public-private partnerships;

[51] Sections 12-4, 12-7, 12-8, and 12-9 of the Department of Planning, Rules of Practice and Procedure, Rule 12, 'Ohana Dwelling Units.
[52] Kona CDP, pp. 3&4.
[53] *Ibid.* p. 4-33.
[54] *Ibid.*
[55] *Ibid,* Action LU-2.1c. p. 4-40.
[56] *Ibid.* pp. 4-49 & 4-50.

4. To promote coordination and collaboration among the community, government agencies, applicants, landowners, professionals, and educational institutions;
5. To provide education on best design practices to applicants, government staff, community members, educators and students; and,
6. To award and recognize exemplary projects.

Although the Design Center will be administered by the Planning Department and staffed by County employees, the department may organize a technical committee of interdisciplinary volunteers.

Action LU-4.1a raises the possibility of hiring an independent contractor to help set-up the Design Center and assist in its initial operation; Action LU-4.1b speaks to the need to fund positions to staff the Design Center; LU-4.2 makes clear that the Design Center "shall review and approve all master plans prepared for (TOD) floating zones" as well as other specified proposals; Action LU-4.2a amends Chapter 25, the Zoning Code, to require mandatory Design Center review; and Policy LU-4.3 specifies that a Design Center staff member may be assigned to coordinate and expedite the permit approval process for a project.[57]

Further, in Action HSG-e[58] developers, with assistance from the Design Center, are encouraged to:

1. Take advantage of the higher densities permitted in TODs and TNDs to financially support building at least 25% affordable units in a creative manner that results in a mix of housing types, tenures, and affordability (see Policies HSG-4.1 to HSG-4.8);
2. Take advantage of the credits recognized to provide affordable disabled, elderly projects and live-work units (Policy HSG-4.4); and
3. Although no additional credits are offered, strive to provide accessory dwelling (Policy HSG-4.6) and SRO (Policy HSG-6.3) units.

Finally, The Village Design Guidelines, Attachment B, are infused with references to the role of the Design Center. The Design Center, in a sense, is the administrator of the Village Design Guideline. As the Kona CDP makes clear: "The Village Design Guidelines (Attachment B) provide the minimum standards for TODs/TNDs, but do not rigidly constrain creativity".[59]

The Design Center as envisioned in the Village Development Guidelines (VDGs) has not yet been established. Therefore, it is not yet possible to create a TOD via the project district process.[60] The VDGs are in the process of being calibrated, that is, to be precisely adjusted to fit the Kona District. The Kona CDP Action Committee is to

[57] *Ibid.* p. 50.
[58] *Ibid.* pp. 4-96 & 4-97.List edited to include only items directly relevant to the Kaloko Makai Project;
[59] *Ibid.* p. 4-33.
[60] E-mail correspondence from Bennett Mark, Planning Program Manager, County of Hawai'i Planning Department, dated April 26, 2011.

recommend approval of the calibrated VDGs to the Planning Director. Once this occurs, then the Planning Department will be able to use the calibrated VDGs in determining whether a TOD as put forth the in a Project District application meets the VDG requirements.

There was a pre-charette informational meeting on April12, 2011, with the Kaloko Makai applicants, the Planning Department, and various State, County, and federal agencies at which potential transect zones, acreages, and agency concerns, among other topics, were discussed. The Planning Department anticipates that there will be additional charettes, first with governmental agencies and then with the public, prior to a request for approval of a TOD (or a Regional District) utilizing a project district application.

1.8 Summary: The Close Fit Between the Policy Framework and the Kaloko Makai Project

There is a close fit between the County General Plan, the Kona Community Development Plan, and the Village Design Guidelines on the one hand and the Kaloko Makai Project, as described in the Environmental Assessment/ Environmental Impact Statement Notice (September 2010), on the other.

The General Plan goals for housing are:[61]

1. Attain safe, sanitary, and livable housing for the resident of the County of Hawai'i;
2. Attain a diversity of socio-economic housing mix;
3. Maintain a housing supply that allows a variety of choices;
4. Create viable communities with affordable housing and suitable living environments;
5. Seek sufficient production of new affordable and rental and fee-simple housing in the County in a variety of sizes to satisfactorily accommodate the needs and desires of families and individuals;
6. Ensure that housing is available to all persons regardless of age, sex, marital status, ethnic background, and income;
7. Make affordable housing available in reasonable proximity to employment centers; and
8. Encourage and expand home ownership opportunities for residents.

The Kaloko Makai project is designed to meet each of these goals.

The Kona CDP makes clear that a master plan for a TOD project is to further the intent of the Village Design Guideline, namely:[62]

1. Promote transit-oriented and pedestrian-oriented development, to increase transit use, to manage traffic congestion,

[61] County of Hawai'i, General Plan, February 2005 as amended in December 2006, pp 9-10.
[62] County of Hawai'i Planning Department, Kona Community Development Plan: Mapping Kona's Future, Prepared by Wilson Okamoto Corporation, September 2008, p.4-44.

2. Encourage mixed-use, compact development that is pedestrian in scale and sensitive to environmental characteristics of the land, and facilitates the efficient use of public services;
3. Have residences, shopping, employment, and recreational uses located within close proximity with each other and efficiently organized to provide for the daily needs of the residents;
4. Provide for a range of housing types and affordability within pedestrian-oriented, human-scale neighborhoods;
5. Incorporate natural features, open space and cultural features;
6. Provide efficient circulation systems for pedestrians, non-motorized vehicles, and motorists that serve to functionally and physically integrate the various land use activities; and
7. Promote strong neighborhood identity and focus.

These objectives are applicable to a Regional Center as well as a TOD project.

The Kaloko Makai project is designed to meet each of these specific objectives. The inclusion of the Dryland Forest and the Historic Trail speak specifically to objective number 5.

The Village Community Guidelines specify:[63]

1. That Villages and REGIONAL CENTERS be compact, pedestrian-oriented and MIXED USE.
2. That ordinary activities of daily living occur within walking distance of most dwellings, allowing independence to those who do not drive.
3. That interconnected networks of transportation corridors be designed to disperse traffic and reduce the length of automobile trips.
4. That within neighborhoods, a range of housing types and price levels be provided to accommodate diverse ages and incomes.
5. That appropriate building DENSITIES and land uses be provided within walking distance of transit stops.
6. That CIVIC, institutional, and COMMERCIAL activity impart a focused town center and gathering place.
7. That schools could be sized and located to enable children to walk or bicycle to them.
8. That a range of OPEN SPACE including parks, squares, and playgrounds should be distributed within neighborhoods and villages.
9. That the growth of the village stays within a defined edge and thereby helps to establish a compact sense of place.

The requirements set forth in the Village Design Guidelines in effect do a good job of describing the plan for the Kaloko Makai Project. The schools, for example, are located so children can walk or bike to them. The walkability of the Project will vastly reduce the need for short vehicle trips. There is a range of open space in each village and all the villages have defined edges.

[63] Village Design Guidelines, Attachment B, Kona Community Development Plan, September 2008, p. 33.

2. DATA ON SOCIAL ISSUES RELATED TO AFFORDABLE HOUSING

Vol. 1 community interviews found several social issues linked to affordable housing:

1. General affordability concerns – socio-economic impacts of housing.
2. Equity issues – whether longtime local residents are less able to afford housing than are newcomers.
3. Whether HUD/County guidelines (unintentionally but effectively) discriminate against local working populations and fail to provide housing for which they can qualify – a different and more specific equity issue.

We shall address the first two in a combined fashion, and the third thereafter, by using available data from two different U.S. Census datasets:

- The 2000 Census "Summary File 3" (SF3), presenting results from the old 15% "long-form survey" that used to be part of every decennial census. Though these data are old, they provide some information not available in more recent census datasets, and also provide a benchmark to indicate housing cost increase since 2000.
- The American Community Survey (ACS) averaged 2005-09 data. The ACS replaced the old "long-form survey," which was not done for the 2010 Census – the 2010 Census contains only very limited housing or social information. This information has instead been gathered in annual ACS surveys, but with quite small samples for areas with population as low as North Kona's.

  For areas such as North Kona, the Census is only releasing five-year averaged data. The recently-released 2005-09 averaged data is the first such release, and represents the most recent available Census information on many housing topics. All dollar figures are in 2009 dollars. It should be noted that this particular five-year period is unique because the first part of it includes an economic boom period, while the last part of it includes the Great Recession. It should also be noted that the 2005-09 ACS contains most, but not all, of the detailed data from the 2000 SF3.

2.1 General Affordability and Equity

The true equity concern is more about newcomers vs. longtime residents, but what the Census actually provides are data broken down by broad "racial" (in Hawai'i, that would be interpreted more as "ethnic") categories, based on respondent self-reports:

1. White Alone
2. Black or African-American Alone
3. American Indian and Alaska Native Alone
4. Native Hawaiian or Other Pacific Islander (NHPI) Alone

5. Some Other Race Alone
6. Two or More Races (which we will call "Mixed Race")

Hawai'i County generally and North Kona in particular have very few people falling into the Black, American Indian, or Other Race categories. However, ***we will use "White Alone" as a proxy for "newcomers" to Hawai'i and the Asian, NHPI, and Mixed Race categories as proxies for "local" residents.*** This is validated by the following data from the 2005-09 ACS:

Table 2.1 Percentage Born in Hawai'i by Ethnicity, 2005-09 ACS

	Total	White	Asian	Mixed Race	NHPI	All "Local"
Hawai'i County Overall	57.9%	25.9%	69.1%	85.2%	81.8%	78.1%
North Kona Census Division	41.6%	15.3%	54.3%	82.1%	67.7%	69.3%
South Kona Census Division	51.8%	18.1%	76.2%	82.4%	70.0%	78.2%
South Kohala Census Division	47.6%	28.3%	52.8%	78.0%	83.7%	68.4%

Census data on housing "cost" are of two main types: Owner-occupied householder estimated values (and sometimes mortgage-related costs) and renter-occupied reports about gross rents, including utilities, etc. (Note that there are no Census data on second-home values/costs.) Another key housing cost measure both for owners with mortgages and for renters has to do with percentage of monthly income going to mortgage or gross rental cost – households spending more than 30% of their incomes for housing are generally viewed as facing serious affordability issues.

The 2005-09 ACS provides these data for the total population but not ethnic/racial categories. The 2000 Census SF3, however, does give such information for the major categories – as well as for some finer-grained ethnic categories not available in the ACS. Table 2.2 and Table 2.3 on the following pages show these data (adjusted to 2009 dollars) for the County as a whole and for the three districts comprising the West Hawai'i study area. The exhibits also show the more recent 2005-09 housing cost information for the total population only, giving a rough sense of change since 2000.

West Hawai'i Housing Costs Compared to Countywide Averages: Both owner- and renter-occupied costs in West Hawai'i (and particularly North Kona) far exceeded the countywide averages in 2000 and grew even more expensive over the following years.

- Overall housing values in North Kona were much higher than county averages in 2000. This was also true for South Kona and South Kohala, though not so much as North Kona. By 2005-09, housing values had increased islandwide, but even more rapidly in North Kona (essentially doubling) and South Kohala. The escalation exceeded growth in income as shown by proportion paying 30% or more for mortgage – 62% of North Kona households, up from 42% in 2000.
- Rents in North Kona also exceeded countywide averages in 2000, but not nearly as much. South Kohala was more the "high rent" area; South Kona, less so. By 2005-09, rents also increased in real terms, though nowhere near as much as values. Again, the proportion paying 30% or more for rents went up (especially in South Kona), but not as much as for values. The increase was greatest for South Kohala, again indicating a greater rental shortage there than elsewhere in West Hawai'i.

Table 2.2 Total and Ethnic-Specific Housing Costs for Owner-Occupied Units

(All values from 2000 Census except first row; all dollar values in 2009 dollars.)	Ethnic Distribution of Owner-Occupied Units[a] In County	Median Value of Owner-Occupied Units[b] In Wide	Ratio of White Median to Other Groups	Paying 30% or More of Household Income for Mortgage[c] County	Ethnic Distribution of Owner-Occupied Units[a] In North Kona	Median Value of Owner-Occupied Units[b] In North Kona	Ratio of White Median to Other Groups	Paying 30% or More of Household Income for Mortgage[c] N. Kona
Totals, Averaged 2005-09 Census[d]		$356,700		45.9%		$604,900		61.5%
Total, 2000 Census[d]	100.0%	$204,030	NA	37.2%	100.0%	$310,492	NA	42.2%
White-Alone Householder	38.1%	$170,700	1.00	40.4%	66.0%	$334,168	1.00	43.0%
Asian-Alone Householder	35.7%	$149,700	1.14	33.0%	21.1%	$268,420	1.33	37.3%
Mixed-Race Householder	17.5%	$145,800	1.17	38.7%	13.3%	$277,173	1.28	39.9%
Native Hwn/Other Pacific Island Householder[e]	7.5%	$134,800	1.27	35.4%	8.3%	$202,171	1.75	48.8%
Any Native Hawaiian Householder[e]	18.3%	$141,100	1.21	38.1%	17.0%	$234,561	1.51	39.9%
Filipino-Alone Householder[e]	8.2%	$125,900	1.36	35.7%	6.6%	$261,072	1.41	42.6%
Japanese-Alone Householder[e]	23.6%	$157,600	1.08	32.2%	13.4%	$291,244	1.22	37.6%

(All values from 2000 Census except first row; all dollar values in 2009 dollars)	Ethnic Distribution of Owner-Occupied Units[a] In South Kona	Median Value of Owner-Occupied Units[b] In South Kona	Ratio of White Median to Other Groups	Paying 30% or More of Household Income for Mortgage[c] S. Kona	Ethnic Distribution of Owner-Occupied Units[a] In South Kohala	Median Value of Owner-Occupied Units[b] In South Kohala	Ratio of White Median to Other Groups	Paying 30% or More of Household Income for Mortgage[c] S. Kohala
Totals, Averaged 2005-09 Census (ACS)		$434,400		48.0%		$515,400		48.0%
Total, 2000 Census[d]	100.0%	$292,881	NA	40.0%	100.0%	$273,456	NA	43.3%
White-Alone Householder	42.4%	$312,816	1.00	40.5%	48.0%	$302,660	1.00	47.7%
Asian-Alone Householder	33.1%	$261,609	1.20	32.8%	20.0%	$268,460	1.17	42.2%
Mixed-Race Householder	15.1%	$260,712	1.20	40.4%	21.2%	$254,340	1.19	35.6%
Native Hwn/Other Pacific Island Householder[e]	8.6%	$255,635	1.22	59.8%	10.6%	$212,658	1.42	39.1%
Any Native Hawaiian Householder[e]	20.3%	$264,429	1.18	50.5%	27.1%	$232,305	1.30	38.0%
Filipino-Alone Householder[e]	4.1%	$246,110	1.27	64.1%	6.1%	$224,507	1.35	60.0%
Japanese-Alone Householder[e]	26.2%	$263,500	1.19	29.4%	12.3%	$277,969	1.09	40.9%

[a]Smaller groups not shown but included in total: African-American, American Indian, Other Race (each "alone").
[b]Units for which estimated values are available. Values are in 2009 dollars (2000 values updated by using Honolulu CPI; ACS values given in 2009 dollars).
[c]Only units with mortgage, excluding units for which data not available.
[d]These are Pacific Islanders alone (and about 95% were "Native Hawaiian alone").
[e]Both Native Hawaiians alone and also part-Hawaiians who were included in "Two or More Races" above.
Filipino-alone and Japanese-alone were each part of "Asian-Alone" group.

Table 2.3 Total and Ethnic-Specific Housing Costs for Renter-Occupied Units

(All values from 2000 Census except first row; all dollar values in 2009 dollars.)	Ethnic Distribution of Renter-Occupied Units[b] in County	Median Gross Rent, Renter-Occupied Units[b] County-Wide	Ratio of White Median to Medians of Other Groups, County-Wide	Paying 30% or More of Household Income for Gross Rent,[c] County	Ethnic Distribution of Renter-Occupied Units[b] in North Kona	Median Gross Rent Renter-Occupied Units[b] in North Kona	Ratio of White Median to Medians of Other Groups, North Kona	Paying 30% or More of Household Income for Gross Rent,[c] N. Kona
Totals, Averaged 2005-09 Census (ACS)		**$1,011**		**47.4%**		**$1,204**		**46.1%**
Total, 2000 Census[a]	100.0%	$866	N/A	43.0%	100.0%	$989	N/A	41.8%
White-Alone Householder	41.7%	$928	1.00	42.5%	56.0%	$1,077	1.00	43.8%
Asian-Alone Householder	17.6%	$748	1.24	37.6%	10.3%	$923	1.17	34.2%
Mixed-Race Householder	25.7%	$834	1.11	43.0%	20.7%	$941	1.14	35.6%
Native Hwn/Other Pacific Island Householder[d]	11.5%	$820	1.13	50.9%	8.6%	$925	1.16	51.5%
Any Native Hawaiian Householder[e]	*25.7%*	*$826*	*1.12*	*44.4%*	*18.3%*	*$1,004*	*1.07*	*42.3%*
Filipino-Alone Householder[f]	*6.6%*	*$725*	*1.28*	*32.6%*	*2.9%*	*$864*	*1.25*	*37.2%*
Japanese-Alone Householder[f]	*8.9%*	*$701*	*1.32*	*39.4%*	*4.7%*	*$888*	*1.21*	*33.9%*

(All values from 2000 Census except first row; all dollar values in 2009 dollars.)	Ethnic Distribution of Renter-Occupied Units[b] in South Kona	Median Gross Rent, Renter-Occupied Units[b] in South Kona	Ratio of White Median to Medians of Other Groups, South Kona	Paying 30% or More of Household Income for Gross Rent,[c] S. Kona	Ethnic Distribution of Renter-Occupied Units[b] in South Kohala	Median Gross Rent, Renter-Occupied Units[b] in South Kohala	Ratio of White Median to Medians of Other Groups, South Kohala	Paying 30% or More of Household Income for Gross Rent,[c] S. Kohala
Totals, Averaged 2005-09 Census (ACS)		**$882**		**50.8%**		**$1,415**		**36.1%**
Total, 2000 Census[a]	100.0%	$769	N/A	36.0%	100.0%	$1,077	N/A	30.3%
White-Alone Householder	47.3%	$933	1.00	38.8%	47.8%	$1,200	1.00	33.6%
Asian-Alone Householder	21.1%	$625	1.49	23.0%	14.0%	$1,005	1.19	25.8%
Two-or-More Races Householder	20.4%	$656	1.42	43.9%	23.7%	$1,031	1.16	30.1%
Native Hwn/Other Pacific Island Householder[d]	10.0%	$767	1.22	39.4%	12.2%	$1,034	1.16	22.6%
Any Native Hawaiian Householder[e]	*20.8%*	*$774*	*1.21*	*40.8%*	*24.3%*	*$1,059*	*1.13*	*26.9%*
Filipino-Alone Householder[f]	*8.3%*	*$459*	*2.03*	*21.8%*	*5.0%*	*$1,005*	*1.19*	*20.5%*
Japanese-Alone Householder[f]	*11.3%*	*$609*	*1.53*	*25.0%*	*6.7%*	*$873*	*1.37*	*30.5%*

[a]Smaller groups not shown but included in total: African-American, American Indian, Other Race (each "alone").
[b]Units with cash rents. Values are in 2009 dollars (2000 values updated by using Honolulu CPI; ACS values given in 2009 dollars).
[c]Only units with mortgage, excluding units for which data not available.
[d]These are Pacific Islanders alone (and about 95% were "Native Hawaiian alone").
[e]Both Native Hawaiians alone and also part-Hawaiians who were included in "Two or More Races" above.
[f]Filipino-alone and Japanese-alone were each part of "Asian-Alone" group.

Ethnic Differences in West Hawai'i Compared to Countywide Patterns: The foregoing Table 2.2 and Table 2.3 further indicate that Whites generally pay more (and/or can afford more) for housing than do "local" groups on an islandwide basis. These islandwide patterns also exist in West Hawai'i – in some cases with even greater disparities; in other cases just reflecting islandwide patterns but at higher dollar levels.

- Whites in 2000 reported higher values than other groups, both countywide and in all three West Hawai'i districts. The gap between values reported by Whites and by other groups was particularly great in North Kona. Elsewhere in West Hawai'i, the ratios of Whites to other groups' medians were similar to countywide ones. In terms of households paying 30% or more of income for mortgages, Whites in West Hawai'i had only slightly higher than countywide average figures, and some other groups in West Hawai'i were paying even higher percentages for housing.

  Both these patterns suggest that incomes are generally higher in West Hawai'i than for the county as a whole, and even more so for Whites than for other groups. (The following analysis of 2005-09 ACS data will generally confirm this.)

- Whites in 2000 also paid higher rents than other groups, both countywide and in all three West Hawai'i districts. However, the relative differential between Whites and other groups was very similar to countywide averages for North Kona and South Kohala – only in South Kona did Whites pay *much* higher rents than did most non-White "local" groups, compared to countywide ratios. In terms of households paying 30% or more of income for rent, White proportions were close to those of other groups – it was the "NHPI alone" (mostly people saying they were Native Hawaiians alone) who were bearing the greatest burden, islandwide and in North Kona (though less heavily in the rest of West Hawai'i).

  Again, these patterns simply suggest that West Hawai'i incomes are elevated for all groups compared to countywide averages, but even more so for Whites than others.

Reasons Whites (Newcomers) Pay More: It is possible there are some social reasons (e.g., family or other social networks) allowing non-White "locals" to locate better housing "deals," and pay less. The Census data do not permit examination of that hypothesis, but they do permit examination of the other hypothesis stated above – that Whites have higher incomes and can therefore afford more. Table 2.4 indicates this hypothesis happens to be true for West Hawai'i, but is not uniformly true islandwide.[64]

[64] As previously noted, race/ethnicity is used here as a proxy for "newcomers" vs. "longtime residents." A non-Census dataset – the 2009 Hawai'i Health Surveillance Survey – permits some limited examination of countywide household median incomes by those variables. Courtesy of SMS Research, which holds rights to that data, we found that medians for people born in Hawai'i actually fell in between the values for newcomers who had been here 10 or more years and those who had moved within the last 10 years. The lower incomes for "newcomers" who had been here longer could reflect reduced incomes among retirees:

	County Total	Lifetime Resident	Moved 10+ Yr Ago	Moved in Last 10 Yr
Median Household Income	$50,176	$50,192	$45,721	$55,015
Pct. of Total Sample (N = 960)	100.0%	48.3%	35.4%	15.5%

Table 2.4 Median Incomes by Race and Census Division, 2005-09 ACS

Median Household Income	Total	White	Asian	Mixed Race	NHPI	"Local"[a]
Hawai'i County Overall	**$53,645**	***$55,845***	**$58,732**	**$54,098**	**$49,868**	**$52,738**
Hilo	$53,926	$47,048	$60,210	$57,558	$46,295	*$51,350*
Honoka'a-Kukuihaele	$59,258	$59,808	$44,609	$62,679	$62,159	$59,740
Ka'ū	$41,911	$37,917	$35,078	$49,627	$40,288	*$43,247*
Kea'au-Mountain View	$40,567	$39,731	$49,206	$37,926	$39,086	$40,872
North Hilo	$67,782	*$72,143*	$72,750	$26,111	$55,625	$51,832
North Kohala	$61,234	$56,154	$50,536	$73,315	$74,440	*$68,588*
Pa'auhau-Pa'auilo	$61,535	*$62,197*	$56,389	$71,722	$51,250	$58,998
Pāhoa-Kalapana	$36,914	$31,879	$58,155	$45,669	$56,136	*$53,142*
Pāpa'ikou-Wailea	$44,182	*$56,250*	$43,661	$43,875	$41,833	$42,523
West Hawai'i Study Area						
North Kona	$54,802	*$66,151*	$66,784	$58,440	$55,743	$58,819
South Kona	$58,849	*$65,219*	$63,500	$47,000	$39,306	$45,973
South Kohala	$75,912	*$78,826*	$70,337	$66,979	$42,349	$55,556

Median Family Income	Total	White	Asian	Mixed Race	NHPI	"Local"
Hawai'i County Overall	**$65,372**	***$67,038***	**$69,536**	**$55,969**	**$56,604**	**$62,805**
Hilo	$66,918	$57,550	$77,698	$64,079	$56,304	*$70,583*
Honoka'a-Kukuihaele	$75,583	$78,478	$74,167	$75,639	$87,578	$76,403
Ka'ū	$44,713	*$48,507*	$42,750	$37,292	$39,813	$39,706
Kea'au-Mountain View	$45,813	*$47,390*	$50,294	$35,959	$44,375	$43,997
North Hilo	$72,885	*$84,219*	$72,833	$84,167	$64,375	$72,390
North Kohala	$71,090	*$71,750*	$81,905	$71,083	$73,793	$68,356
Pa'auhau-Pa'auilo	$70,903	*$84,444*	$63,824	$47,083	$28,807	$52,700
Pāhoa-Kalapana	$46,473	$38,947	$68,482	$46,366	$60,761	*$56,003*
Pāpa'ikou-Wailea	$56,792	*$78,750*	$55,000	$44,125	$27,000	$48,626
West Hawai'i Study Area						
North Kona	$69,626	*$75,324*	$72,007	$59,789	$59,211	$65,160
South Kona	$76,354	*$82,404*	$70,266	$71,875	$60,865	$69,517
South Kohala	$77,079	*$83,125*	$74,655	$69,250	$51,954	$68,571

Median Non-Family Income	Total	White	Asian	Mixed Race	NHPI	"Local"
Hawai'i County Overall	**$32,267**	***$34,831***	**$24,878**	**$35,094**	**$24,735**	**$27,797**
Hilo	$26,794	$28,421	$25,352	$35,373	$23,285	$27,023
Honoka'a-Kukuihaele	$19,506	$27,083	$18,648	$28,816	$61,250	$28,947
Ka'ū	$23,468	$22,188	$23,500	$14,625	$27,000	$21,806
Kea'au-Mountain View	$27,103	$25,536	$31,923	$39,702	$22,500	*$33,004*
North Hilo	$14,735	$13,162	$24,500	$14,375	$33,529	*$20,520*
North Kohala	$32,629	*$35,054*	$19,688	$34,286	$25,313	$23,241
Pa'auhau-Pa'auilo	$50,160	*$52,857*	$21,818	$36,406	N/A	$23,832
Pāhoa-Kalapana	$24,542	$21,855	$19,375	$27,000	$50,125	*$29,901*
Pāpa'ikou-Wailea	$16,923	$13,289	$16,481	$37,143	$42,833	*$24,286*
West Hawai'i Study Area						
North Kona	$44,429	*$48,840*	$31,618	$38,182	$25,463	$32,882
South Kona	$27,736	*$32,813*	$21,250	$16,429	$14,861	$17,888
South Kohala	$47,377	*$53,117*	$45,607	$38,177	$14,342	$39,056

Italicized numbers in yellow *$XX,XXX* show "White" or "Local" with higher median for the area. Those pairs with no italics are so close as to be essentially equal.

[a]Median Income for "Local" estimated from Census data on numbers in different age categories.

Note in Table 2.4 that – especially in West Hawai'i – Asian incomes tend to be very close to, and sometimes a little greater than, White incomes. The "Local" household and median incomes are lower than Asian incomes because of the effects of Mixed Race and NHPI (Native Hawaiian and Pacific Islander) lower incomes. The ACS does not permit analysis by "Any Native Hawaiian" (alone or mixed), but numbers from the 2000 Census indicate that ***people who are at least part-Hawaiian accounted for between 70% and 80% of the combined NHPI and Mixed-Race categories*** in the overall county or the three West Hawai'i districts. Thus, again, it would appear to be Native Hawaiians who are having a particularly difficult time economically in West Hawai'i compared to Whites or even to Asians.

These income disparities reflect overall group differences shown below in:

- Education – better educated workers earn more throughout the nation;
- Age – older and more experienced workers usually earn more, and incomes are greater in the prime 25-64 working years (the 2005-09 ACS indicates householders in those years had median incomes about 50% greater than younger or older ones);
- Family Structure – female single-parent households face particularly economic challenges (the 2005-09 ACS found a countywide median of just $23,950 for single mothers, vs. $36,600 for single fathers and $78,900 for couples with children).

Table 2.5 Factors Related to Income, by Race, 2005-09 ACS

	Hawai'i County						North Kona					
	Total	White	Asian	Mixed Race	NHPI	All "Local"	Total	White	Asian	Mixed Race	NHPI	All "Local"
Education for Population 25+												
% Lacking High School Diploma	9.0%	6.4%	13.9%	6.4%	13.0%	12.0%	8.7%	4.0%	10.5%	12.1%	16.8%	12.3%
% Bachelor's Degree or More	26.2%	35.4%	25.7%	14.4%	13.3%	20.0%	27.5%	37.8%	24.4%	9.4%	15.7%	17.2%
Age												
Median Age[a]	39.4	46.9	49.0	22.4	32.1	34.8	40.3	50.2	41.6	25.8	31.6	32.8
% Population in 25-64 Age Group	54.1%	62.4%	55.4%	42.1%	61.3%	49.0%	57.6%	65.2%	59.6%	45.6%	61.9%	51.8%
% Population in 65+ Age Group	13.7%	15.1%	24.1%	4.6%	9.2%	13.3%	13.0%	16.9%	18.2%	5.9%	4.4%	10.6%
Composition of Family Households												
Female Householder, Children Under 18	12.3%	9.2%	8.9%	20.3%	18.7%	14.6%	9.9%	8.8%	9.4%	9.6%	22.6%	11.9%

	South Kona						South Kohala					
	Total	White	Asian	Mixed Race	NHPI	All "Local"	Total	White	Asian	Mixed Race	NHPI	All "Local"
Education for Population 25+												
% Lacking High School Diploma	9.7%	6.2%	10.3%	15.2%	9.8%	13.4%	7.0%	4.7%	12.1%	2.9%	17.0%	10.1%
% Bachelor's Degree or More	24.8%	33.8%	24.8%	9.1%	5.5%	16.2%	31.1%	41.0%	24.1%	19.2%	6.2%	19.4%
Age												
Median Age[a]	45.1	48.5	53.3	21.3	43.7	38.0	38.7	42.4	38.3	22.4	32.8	30.4
% Population in 25-64 Age Group	55.7%	58.0%	53.3%	36.8%	54.3%	46.6%	60.5%	61.2%	68.2%	45.7%	40.6%	50.0%
% Population in 65+ Age Group	15.6%	13.0%	26.9%	8.8%	17.5%	17.8%	10.3%	13.1%	11.2%	2.5%	14.1%	8.3%
Composition of Family Households												
Female Householder, Children Under 18	9.0%	9.3%	10.0%	14.0%	0.0%	10.0%	12.0%	8.9%	12.7%	25.8%	29.8%	20.2%

[a]Median Age for "Local" estimated by JMK Associates from Census information about numbers in different age categories.

Table 2.6 HUD Guidelines for Hawai'i County as of Mid 2009

AFFORDABLE HOUSING GUIDELINES FOR THE COUNTY OF HAWAI'I

FOR-SALE UNITS GUIDELINES *(Effective 07/02/09)*

This information is based on 2009 median income established by the U.S. Department of Housing and Urban Development (HUD) for various family sizes. Adjustments to the very low- (50%) and low-income (80%) limits are made by HUD for areas with unusually high or low family income or housing costs. Most income limits are proportionately based on very low-income limits. Thus, the four-person (60%) income limit is 120% (6/5ths) of the four-person very low-income limit.

The figures consider (1) a 30-year conventional fixed mortgage; (2) a fixed interest rate of 6.06%*; (3) housing expenses equal to 28% of gross annual income; and (4) a down payment equal to 5% of the sales price. *The interest rate used is the annual average interest rate for a 30-year conventional fixed mortgage, for the twelve months ending in the previous year, as published by the Federal Home Loan Mortgage Corp (http://www.freddiemac.com/pmms/docs/30yr_pmms_mth.txt). The rate is rounded to the nearest half percent.

% of Median	50%	60%	70%	80%	90%	100%	110%	120%	130%	140%
FAMILY SIZE: 1										
Income	$ 23,850	$ 28,980	$ 33,110	$ 37,800	$ 42,570	$ 45,570	$ 50,130	$ 54,660	$ 59,240	$ 63,800
Sales price	$ 99,900	$ 116,300	$ 135,800	$ 154,900	$ 174,400	$ 188,700	$ 205,400	$ 224,000	$ 242,700	$ 261,400
FAMILY SIZE: 2										
Income	$ 27,000	$ 32,400	$ 37,800	$ 43,200	$ 48,600	$ 52,080	$ 57,290	$ 62,500	$ 67,700	$ 72,913
Sales price	$ 119,600	$ 132,700	$ 154,800	$ 177,000	$ 199,100	$ 213,400	$ 234,700	$ 256,000	$ 277,300	$ 298,700
FAMILY SIZE: 3										
Income	$ 30,400	$ 36,480	$ 42,560	$ 48,600	$ 54,720	$ 58,590	$ 64,450	$ 70,310	$ 76,170	$ 82,033
Sales price	$ 124,500	$ 149,400	$ 174,400	$ 199,100	$ 224,200	$ 240,000	$ 264,000	$ 288,000	$ 312,000	$ 336,000
FAMILY SIZE: 4										
Income	$ 33,750	$ 40,500	$ 47,250	$ 54,000	$ 60,750	$ 65,100	$ 71,610	$ 78,120	$ 84,630	$ 91,143
Sales price	$ 138,300	$ 165,900	$ 193,600	$ 221,200	$ 248,900	$ 266,700	$ 293,400	$ 320,000	$ 346,700	$ 373,400
FAMILY SIZE: 5										
Income	$ 36,450	$ 43,740	$ 51,030	$ 58,300	$ 65,610	$ 70,310	$ 77,340	$ 84,370	$ 91,400	$ 98,430
Sales price	$ 149,300	$ 179,200	$ 209,100	$ 238,800	$ 268,800	$ 288,000	$ 316,800	$ 345,600	$ 374,400	$ 403,200
FAMILY SIZE: 6										
Income	$ 38,150	$ 46,980	$ 54,810	$ 62,650	$ 70,479	$ 75,520	$ 83,070	$ 90,620	$ 98,170	$ 105,722
Sales price	$ 160,400	$ 192,500	$ 224,500	$ 256,200	$ 288,700	$ 309,400	$ 340,300	$ 371,200	$ 402,200	$ 433,100

FOR-SALE FINISHED LOTS GUIDELINES *(Effective 07/02/09)*

This information is based on the affordable sales price for a completed unit for a household, earning one hundred percent of the median income in the County of Hawai'i, less the cost to build a single-family home of 1,100 square feet. *$150 per square foot cost is based on estimates by The County of Hawai'i, Department of Public Works, Building Division.

% of Median Income	Affordable Home Price	-	Cost/Unit	=	Affordable Lot Price
50%	$ 221,200	-	$ 165,000	=	$ 56,200
100%	$ 266,700	-	$ 165,000	=	$ 101,700

FOR-RENT GUIDELINES *(Effective 07/02/09)*

Affordable rents are based on 30% of gross monthly income, including utilities (water, sanitary sewage service, electricity and/or gas). Please refer to form HUD-52667(Allowances for Tenant-Furnished Utilities and Other Services) for utilities for either single- and/or multi-family units.

Bedroom Size		Studio	One	Two	Three	Four
	30%	$ 355	$ 380	$ 456	$ 526	$ 587
	50%	$ 591	$ 633	$ 760	$ 877	$ 978
	60%	$ 709	$ 759	$ 912	$ 1,053	$ 1,174
% of Median Income	80%	$ 945	$ 1,012	$ 1,216	$ 1,403	$ 1,566
	100%	$ 1,139	$ 1,220	$ 1,464	$ 1,692	$ 1,888
	120%	$ 1,367	$ 1,464	$ 1,757	$ 2,031	$ 2,265
	140%	$ 1,595	$ 1,708	$ 2,050	$ 2,369	$ 2,643

Summary: General conclusions to be drawn from all the previous analyses would be –

- All groups – newcomer/longtime residents or ethnic/racial groups – face serious affordability issues in regard to housing in West Hawai'i (especially North Kona).
- Whites (viewed as a proxy for newcomers) pay more on average for housing in West Hawai'i, but it is not clear whether that means they are bidding up housing costs or just less able to find better housing "deals" than longtime residents. Higher housing costs for Whites is part of an islandwide pattern, even though Whites don't always have higher incomes than other groups outside West Hawai'i.
- Native Hawaiians (and perhaps Filipinos) are particularly challenged in West Hawai'i due to lower overall incomes that reflect differences in overall education, age, and family structure. In the future, they will likely comprise a greater proportion of the "local" population, because the Asian population is aging (Table 2.5).

2.2 Effect of Median Income Guidelines on "Local" Qualification for Housing

The question here – raised by a number of community interviewees – is whether "affordable housing" projects provided in response to County guidelines are truly affordable, especially for "local" working families.

The federal Department of Housing and Urban Development (HUD) sets guidelines for any for-sale or rental "affordable housing" projects in all U.S. areas, including Hawai'i County. Because this analysis considers data in 2009 dollars, HUD guidelines for Hawai'i County effective July 2009 are reproduced on the following page (provided courtesy of the County's Office of Housing and Community Development) as Table 2.6. To derive these guidelines, HUD uses a complex procedure that still begins with 2000 Census figures but also integrates updated data from various sources, including recent ACS data for both County and State (but not the most recent ACS, as that is still being collected during or after the period the guidelines are issued).

Thus, the 2009 income figures in the 2005-09 ACS provides an indication of factors that affect (future) County guidelines, but not a direct analysis of the guidelines themselves.

Comparing HUD Assumed Medians with Census Medians: Following the HUD guideline information, Table 2.7 compares HUD's assumed 100% median figure for the County (effective mid-2009) with "actual" medians from the ACS. However, it should be remembered the ACS is still a survey, and so has sampling error. Also, the comparison is imperfect because the averaged ACS median incomes include pre-recession figures.

- Subject to these caveats, Table 2.7 indicates Hawai'i County residents probably had higher medians than assumed by HUD, making it easier to qualify for affordable housing projects.
- West Hawai'i residents had even higher incomes than countywide averages, meaning it was even easier to qualify there, compared to the rest of the island.

Table 2.7 Median Family Incomes, HUD Guidelines Versus 2005-09 ACS Values

	HUD	ACS 2005-09 (2009 dollars)			
	Hawai'i County	Hawai'i County	North Kona	South Kona	South Kohala
Total:		$65,372	$69,626	$76,354	$77,079
1-person families	$45,570	N/A	N/A	N/A	N/A
2-person families	$52,080	$57,186	$67,072	$65,739	$71,442
3-person families	$58,590	$64,217	$65,965	$78,500	$77,468
4-person families	$65,100	$75,513	$70,823	$91,131	$86,591
5-person families	$70,310	$71,497	$84,154	$89,938	$86,472
6-person families	$75,520	$94,267	$115,017	$80,500	$148,686
7+-person families	N/A	$83,099	$82,813	$133,750	$74,495

Note: Census definition of "family" includes mostly couples or people with own children under 18. If there is only one person – or unrelated people – in a unit, the Census considers that a "non-family household." The ACS provides data on overall household (families and non-families combined) median income, but does not break this out by household size. As previously noted, the 2005-09 ACS median household income for Hawai'i County was $55,645.

The reason that areas (or groups) with higher median incomes have a somewhat harder time qualifying under a median-based system is that the higher median indicates proportionately more people make "too much money" to qualify. For example, HUD's 100% median qualification point for a two-person household in mid-2009 was a little over $50,000. Table 2.8 switches to household incomes to show varying percentages falling under a $50,000 median point (ignoring household size for the moment):

Table 2.8 Percentages Exceeding $50,000 Household Income, by Race and District, 2005-09 ACS

	Hawai'i County						North Kona					
	Total	White	Asian	Mixed Race	NHPI	All "Local"	Total	White	Asian	Mixed Race	NHPI	All "Local"
% Households Earning Under $50,000												
All Households	44.9%	44.9%	42.4%	46.7%	50.1%	46.1%	36.7%	34.7%	35.6%	42.0%	45.6%	39.8%
- Householders Under 25	59.2%	58.6%	64.6%	50.6%	68.7%	64.3%	41.6%	42.6%	52.2%	10.0%	92.6%	45.6%
- Householders 25-44	39.4%	39.0%	34.6%	42.7%	44.2%	40.3%	34.2%	20.6%	30.7%	42.1%	39.7%	30.6%
- Householders 45-64	39.2%	41.2%	20.0%	45.7%	43.6%	38.7%	31.3%	31.3%	22.4%	38.5%	37.4%	31.3%
- Householders 65+	60.8%	58.0%	61.6%	62.6%	66.2%	62.3%	51.1%	46.6%	52.9%	66.0%	58.3%	57.0%

	South Kona						South Kohala					
	Total	White	Asian	Mixed Race	NHPI	All "Local"	Total	White	Asian	Mixed Race	NHPI	All "Local"
% Households Earning Under $50,000												
All Households	44.7%	42.6%	42.2%	62.1%	53.0%	47.7%	28.4%	24.6%	28.8%	38.6%	50.0%	35.9%
- Householders Under 25	91.3%	XXX	XXX	XXX	XXX	XXX	45.6%	XXX	60.0%	44.0%	XXX	38.8%
- Householders 25-44	41.7%	50.7%	46.1%	32.6%	61.1%	32.3%	17.7%	11.0%	27.0%	28.4%	23.8%	27.3%
- Householders 45-64	37.2%	36.1%	16.9%	58.1%	63.6%	40.1%	23.8%	19.5%	27.8%	47.1%	38.8%	32.5%
- Householders 65+	58.8%	43.3%	65.0%	69.6%	68.4%	68.7%	58.2%	54.0%	46.3%	84.0%	79.7%	63.1%

Shaded cells with "XXX" looking like this [illegible] had numbers too small to be reported at all. Shaded cells with % [illegible] = "Caution, small N's"

If $50,000 were actually the sole median point for qualification, 50% should qualify. The Hawai'i County total figure of 45% is in that ballpark, but people in the prime 25-64 working years had just 39% in the hypothetical "qualifying" pool. In North Kona and other West Hawai'i districts (especially South Kohala), the "qualifying" percentages were even lower.

Further Specifying These Conclusions for "Local" Residents: The Census does not provide ethnic/racial breakdowns for the sort of income-by-family-size information shown above in Table 2.7. However, Table 2.8 shows available race-specific numbers by householder age, if not the more ideal family size breakdown. For the great majority of cells in this matrix, the West Hawai'i percentages are smaller than countywide ones, suggesting less ability to qualify for people who live in North Kona, South Kona, or South Kohala than people who live elsewhere on the island. There is no clear or consistent pattern as to whether, for example, Whites throughout West Hawai'i had greater differences from their countywide percentage than any other group.

But qualifying is not just a matter of income but also of family/household size. Although the 2005-09 ACS does not provide household size by ethnic/racial categories, it is generally known that "local" family sizes (especially for Hawaiian or part-Hawaiian households, as well as for Filipinos) tend to be larger. This perception is borne out by data from the 2000 Census (Table 2.9). As of that year, average household sizes for Native Hawaiians were actually less than for Filipinos, although this is likely because of the younger average age among Hawaiians and therefore more households occupied by people who have yet to have all the children they may eventually have.

Still, on average, even Filipino and Native Hawaiian householders were reporting household sizes between 3.4 and 4.1 in 2000, and these household sizes have likely been declining along with those of other groups as time has gone by. That means the 100% median reference point for the typical Native Hawaiian or Filipino household in 2009 still was likely closer to $58,590 or $65,100 (Table 2.9), whereas the 100% median qualifying point would often be lower for Whites due to smaller average household sizes. Basically, households with the same number of income earners but more dependents must earn more to qualify for "affordable housing" projects, but the groups with average lower incomes have historically tended to have larger family sizes.

Table 2.9 Total and Ethnic-Specific Average Household Sizes

(All values from 2000 Census except first row, from 2005-09 ACS.)	Hawai'i County	North Kona	South Kona	South Kohala
Totals, Averaged 2005-09 Census (ACS)	2.67	2.65	2.79	2.58
Total, 2000 Census[a]	2.75	2.70	2.81	2.76
White-Alone Householder	2.38	2.36	2.42	2.38
Asian-Alone Householder	2.74	2.98	2.91	2.58
Mixed-Race Householder	3.21	3.22	3.35	3.58
Native Hwn/Other Pacific Island Householder[b]	3.45	3.49	3.48	3.67
Any Native Hawaiian Householder[c]	3.42	3.43	3.78	3.79
Filipino-Alone Householder[d]	3.55	4.07	3.73	2.88
Japanese-Alone Householder[d]	2.38	2.50	2.26	2.36

[a]Smaller groups not shown but included in total: African-American, American Indian, Other Race (each "alone").
[b]These are Pacific Islanders alone (and about 95% were "Native Hawaiian alone").
[c]Both Native Hawaiians alone and also part-Hawaiians who were included in "Two or More Races" above.
[d]Filipino-alone and Japanese-alone were each part of "Asian-Alone" group.

Closing Comment on the Nature of "Median Income": Something that is taken for granted by housing specialists and other people who work with numbers – but may not be intuitive for others in the public – is that the "median income" is the figure at which 50% of the specified population earns more and 50% earns less. In other words, ***housing that is affordable to a household making exactly the median income for some group is by definition not affordable to half that group's population.***

Thus, the idea that guidelines based on a median-income definition do not help many people qualify for housing is absolutely accurate. This, however, is exactly why the guidelines extend down to 50% of median in the case of for-sale housing and to 30% of housing in the case of rental housing. The question of why relatively little housing gets provided for those very low-end households in Hawai'i is more a matter of land use economics, and a question for a very different type of analysis than can be done with the sort of Census data considered here.

Summary: Housing affordability is a serious concern in West Hawai'i in regard to market housing, and even the HUD-based County guidelines to qualify for subsidized "affordable housing" projects pose more of a challenge to West Hawai'i residents than others on the island – for the ironic reason that West Hawai'i residents earn more and thus have a harder time qualifying.

Some "local" groups – Native Hawaiians and probably Filipinos, whose combined share of the "local" population will probably increase over time – now tend to have lower incomes than newcomers, which arguably increases their "advantage" in qualifying for affordable housing projects. But this "advantage" tends to be reversed by higher average household sizes that mean they must earn more to qualify. The HUD guidelines requiring higher incomes for larger families are logical, based on the assumption that larger housing space must be purchased to accommodate larger families. But there is further irony in the fact that guidelines for "affordable housing" tend to preclude sacrifices that many people have voluntarily decided to make for market housing – e.g., accepting more people in the same space, sub-letting to unrelated tenants, etc.

Ultimately, though, the social challenges facing West Hawai'i will probably have less to do with the fairness of "affordable housing" guidelines than with the soaring prices of market housing. The social impact of the Kaloko Makai project will be positive to the extent that it succeeds in the goal of providing more affordable market housing to working families – a goal that would likely be achieved by greater densities consistent with the Kona Community Development Plan.

J•M•K JOHN M. KNOX & ASSOCIATES, INC.

KALOKO MAKAI SOCIAL IMPACT ASSESSMENT

Volume 3: North Kona Community Planning Survey, 2009

April 6, 2009
(Foreword Added May 2011)

Prepared for:
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FOREWORD (May 2011)

John M. Knox & Associates was engaged to prepare a social impact assessment of the proposed Kaloko Makai mixed-use commercial and residential development in Kona. In accord with Kona Community Plan principles of providing housing choices, recreation opportunities, directing growth patterns towards compact villages and encouraging a diverse and vibrant economy, Stanford Carr Development proposes a 1,142-acre development with a strong emphasis on residential development.

The work is presented in three volumes:

1. Volume 1 (prepared in 2011) presents background socio-economic conditions and results of a community interview process to surface key issues.
2. Volume 2 (also 2011) is a more extensive analysis of housing issues, prepared by subcontractor Tom Dinell (Dinell Associates). Mr. Dinell is Emeritus Professor in the University of Hawai'i Mānoa's Dept. of Urban and Regional Planning, teaching courses on housing there.
3. The current Volume 3 contains results of a 2009 "North Kona Community Planning Survey" that focused on awareness of the new Kona Community Development Plan (CDP) and extent of agreement with key element relevant to the proposed project. This survey was commissioned by Stanford Carr Development as part of the social impact assessment during the early stages of project planning and Environmental Impact Statement preparation work.

SUMMARY AND ANALYSIS OF VOLUME 3 RESULTS

SCD Kaloko Makai, LLC is seeking development approvals for its proposed Kaloko Makai mixed-use community in North Kona. To explore the social impact of the project, the company retained John M. Knox & Associates, Inc. ("JMK Associates") to conduct a telephone survey of 400 North Kona residents. This sample size permits a precision of ±5% for most results.

Key survey purposes and results are summarized below:

Purpose	Results
1. Importance of various possible North Kona community needs – including but not limited to certain elements of the Kaloko Makai project;	When asked to rate importance for a list of 12 possible needs, those related to health and medicine – more doctors and a new hospital – topped the list. Various transportation-related needs (especially mauka-makai connectors), affordable housing, and preserving open space between development were all rated "very important" by majorities of respondents.
2. Awareness of the new Kona CDP, including (for those aware) beliefs about its best and worst parts, extent of community participation, and whether respondents personally provided any response or input to the plan;	• 28% said they read or heard about the plan; • Those aware of the plan gave a wide variety of answers regarding "best" and worst" parts, but 40% to 50% indicated they needed more information; • Of the 28%, 25% said there had been a "great deal" of community input; 37% said "moderate amount;" and the remainder said "very little" or were unsure. Also, 31% (or about 9% of the overall sample) said they had some form of personal input.
3. Agreement with selected key elements of the CDP – particularly those broad planning principles about new transit-oriented developments (TODs) on the future Mid-Level road north of Kailua (as the Kaloko Makai community would be one of these); and	Majorities agreed with eight key principles relevant to planning growth north of Kailua. There was particularly strong agreement that a new hospital should be located on the Mid-Level Road and that some developments should be permitted higher densities around job centers.
4. Awareness of, and reaction to, the Kaloko Makai proposal itself.	• 56% said they had heard of the project. • 71% found the project either "very" or "somewhat" acceptable, with younger people particularly likely to favor it. • The majority who found the project acceptable tended to cite the hospital, housing, schools, and overall "good plan," while the minority who found it unacceptable focused on scale and density.

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PURPOSE

SCD Kaloko Makai, LLC is seeking development approvals for its proposed Kaloko Makai mixed-use community in North Kona. To explore the social impact of the project, the company retained John M. Knox & Associates, Inc. ("JMK Associates") to conduct a telephone survey of North Kona residents. JMK Associates, in conjunction with the client, designed the survey, specified the analyses, and wrote this report, while subcontract FAQ Hawai'i, Inc. did the telephone interviewing and computerized analysis.

Social impact assessment is a diverse and multi-dimensional discipline. Surveys provide one technique for understanding community needs and perceptions, so that policy makers can decide how well a proposed project meshes with community priorities and attitudes.

The proposed Kaloko Makai project will be one of the first to be evaluated following the September 2008 enactment of the new Kona Community Development Plan (CDP). SCD Kaloko Makai believes its project is consistent with the Kona CDP. However, while the CDP was developed over many years with substantial community input, there has never been a public opinion survey about the extent of agreement with the new plan.

Therefore, the purposes of this survey were to determine:

1. The importance of various possible North Kona community needs – including but not limited to certain elements of the Kaloko Makai project;
2. Awareness of the new Kona CDP, including (for those aware) beliefs about its best and worst parts, extent of community participation, and whether respondents personally provided any response or input to the plan;
3. Agreement with selected key elements of the CDP – particularly those broad planning principles about new transit-oriented developments (TODs) on the future Mid-Level road north of Kailua (as the Kaloko Makai community would be one of these); and
4. Awareness of, and reaction to, the Kaloko Makai proposal itself.

METHODS

Timeframe: Interviews were conducted between March 18 and 25, 2009. Calls were made between the hours of 5 and 9 p.m. Mondays through Fridays, and between 10 a.m. and 2 p.m. on Saturdays and 12 noon and 9 p.m. on Sundays.

Sample Size and Precision: The total sample **N of 400** permits a North Kona District precision ("sampling error") of **±5.0%**. There would be less precision (more error) for sub-samples, such as for particular demographic groups in the cross-tabulations at the end of the report.

Sampling Frame: The sampling frame consisted of a Random Digit Dialing (RDD) sample, ordered from Scientific Telephone Samples, a national sampling company that specializes in providing sample to market research companies. The RDD sampling frame consisted of the North Kona telephone prefixes of 322, 324, 325, 326, 327, 329, 331, and 334.

Interviewing Procedures: A training session was held in which the interviewers role-played and practiced the interviews before conducting the surveys with the actual respondents. FAQ Hawai'i's call center interviewers are well-versed in the nuances of a multi-cultural and multi-ethnic population of Hawaii. The interviewers are trained and experienced in conducting telephone surveys. FAQ Hawai'i has a ten-station CATI-equipped call center in downtown Honolulu. ("CATI" stands for Computer-Assisted Telephone Interviewing, a software program that permits interviewers to record answers directly into the overall survey database.)

The call center has a silent monitoring system used for quality control purposes. The supervisor constantly monitors both the respondent (person answering the questions) and the interviewer without being detected by either party.

Information Provided to Respondents on Request: Survey questions about planning issues can be confusing to the average person. On the other hand, lengthy explanations in a survey can be deadly – it is hard to absorb a great deal of new information over the phone, and respondents may simply terminate the call or else respond based on (possible misunderstandings of) snatches of the explanations.

In this case, it seemed appropriate to provide interviewers with limited answers to very basic questions that respondents might ask before they could in turn answer the questions posed to them – e.g., definitions of basic terms used in the questions about the Kona Community Development Plan.

However, interviewers reported that respondents rarely asked them for any such definitions. The most frequent question that interviewers received was, "Who is paying

for this survey?" (Interviewers are almost never told the identity of a client and so could honestly respond they did not know.)

Data Processing and Cross-Tabulations: FAQ Hawai'i processed the data, performing basic cross-tabulations, using SPSS, a statistical program. These cross-tabulations are shown in Appendix B, immediately following Appendix A, which is a print version of the actual computerized questionnaire shows overall results.

Survey Representativeness: Although the last U.S. Census of North Kona was conducted in the year 2000, which makes it difficult to compare with 2009 results, the results for demographic variables shown in Appendix A suggest some bias in the survey:

- Age is likely the most important concern. The proportion of people aged 55 or greater in this sample was about twice what it was for the adult North Kona population in 2000. FAQ Hawai'i reported that people who answered the phones were even more willing to take and complete the survey than is typically the case, and the rates of people not answering phone calls were typical of most surveys. Therefore, the most likely explanation is the growing tendency of young people to have only cell phones, which are usually not in sampling frames.
- The age bias likely accounts for all or most of a number of other disproportionate elements – e.g., likely oversampling of respondents who are highly educated, homeowners, and/or affluent (though the income results look less out of line than the other variables). Older people tend to be more educated, to own homes, and to have higher incomes.
- The sample was also slightly biased toward females (typical for surveys) and Caucasians. The female bias proved unimportant because females and males answered almost every survey question in a similar manner. The Caucasian percentage of 62% is higher than the 2000 Census figure of 46%, but the 46% applies to the entire population, including children, and Caucasians tend to have fewer children than other groups in Hawai'i.

It is possible to adjust for bias by weighting the results to some known population parameter. However, this was not done for the present survey because (1) the Census provides these parameters, and the Census is now out of date; and (2) more importantly, weighting the results by age would actually make the results more favorable to the client. As will be later noted, younger people were much more likely than older ones to find the proposed project "acceptable."

Therefore, the survey results reported here are conservative in that they understate the likely actual percentage of people who would have said the Kaloko Makai is acceptable if the sample had been weighted to correct for the critical age bias.

RESULTS

This section provides an overview of results. For a complete listing, Appendix A contains a paper copy of the computerized questionnaire with percentage results for closed-ended questions. ("Closed-ended" questions have predetermined choices of answers – e.g., yes or no. "Open-ended" questions are those which respondents answer in their own words, and those answers are later coded into categories. Those responses were too numerous to fit into the Appendix A questionnaire format, but are summarized in this section.) The subsequent Appendix B shows survey results cross-tabulated by demographic variables.

1. Importance of North Kona Community Needs

The survey's Question 1 ("Q1") stated: "*First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.*" Twelve different items were listed (Q1a to Q1l).To prevent bias due to question ordering, the starting point for the 12 specific items was randomly rotated.

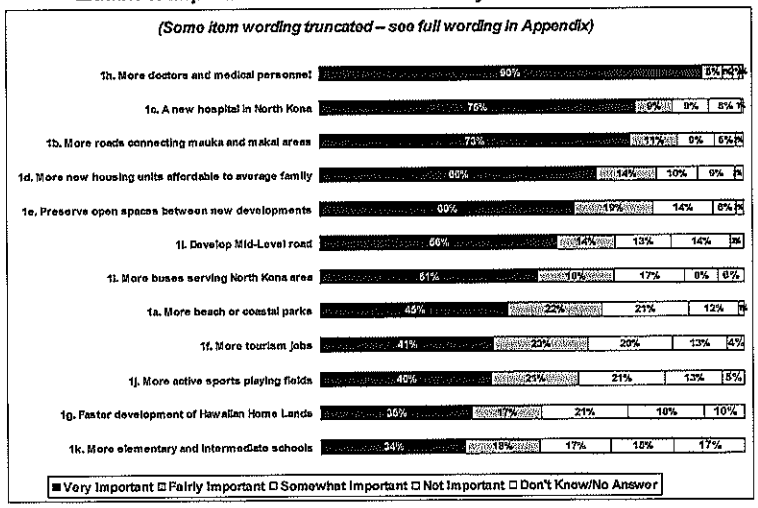
Exhibit 1 presents overall results, ordered by percentage "Very Important." This exhibit shows:

- Of the listed "possible needs," those related to health and medicine – more doctors and a new hospital – topped the list.
- Various transportation-related needs (especially mauka-makai connectors), affordable housing, and preserving open space between development were all rated "very important" by majorities of respondents.
- Relatively lower ratings were accorded the need for more schools, active playing fields, faster development of Hawaiian Home Lands, and more tourism jobs.

The lengthy Appendix B shows all demographic cross-tabulations for the items in Exhibit 1. Some of the more noteworthy patterns from those tables include –

- The strong desire for more doctors and a new hospital was present for all groups. The Mid-Level Road was also generally supported by all demographic groups.
- However, there were some variations for the lower-rated items. "*Faster development of Hawaiian Home Lands areas*" was "very important" to 61% of Native Hawaiians, vs. 30% to 35% of other groups. Both "*More elementary and intermediate schools*" and "*More active sports playing fields*" were of much more importance to younger and/or less educated resident than to older and/or highly-educated ones.

Exhibit 1: Importance of Various Community Needs in North Kona



2. Awareness of, and Beliefs about, Overall Kona CDP

After Q1, immediately following survey questions were:

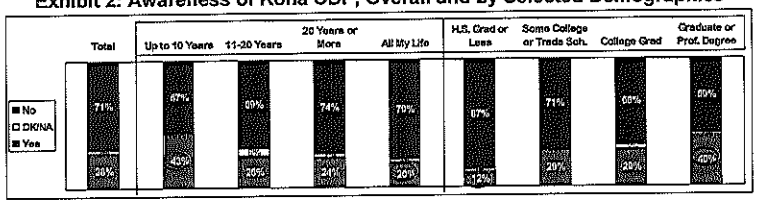
- Q2: "*Have you read or heard that the County just approved a new Kona Community Development Plan?*" (Closed-ended: Yes or no?)
- Q3 [asked only if "yes" to Q2]: "*From what you have read or heard, what do you think are the best parts of this new plan?*" (Open-ended)
- Q4 [asked only if "yes" to Q2]: "*From what you have read or heard, what are the worst parts of the plan, or what worries you about it?*" (Open-ended)
- Q5 [asked only if "yes" to Q2]: "*Do you believe this plan was based on what you would call a great deal of community input, a moderate amount of community input, or very little community input?*" (Closed-ended: great deal, moderate, or very little?)
- Q5a [asked only if "yes" to Q2]: "*Did you personally go to any meetings or have any input to this plan?*" (Closed-ended: Yes or no?)

a. Awareness of New Kona CDP

Exhibit 2 shows overall awareness, as well as several of the more notable demographic differences (length of residence and education).

Overall, 28% said they read or heard about the plan; 71% said they had not; and 1% was unsure. Newcomers (up to 10 years in Hawai'i) were more than twice as likely as lifetime residents to report awareness, and people with the highest possible levels of education were more than three times as likely as the least educated to say they were aware of the plan. These differences were statistically significant.

Exhibit 2: Awareness of Kona CDP, Overall and by Selected Demographics



In addition, residents with very high household incomes ($100,000+) were nearly three times as likely as those with incomes under $35,000 to report awareness, although there was no difference among the various intermediate income categories.

b. Perceived Best and Worst Parts of Plan

The 111 respondents aware of the plan replied in their own words to the questions about best and worst parts, and the original responses were coded into the categories shown in Exhibit 3.

Responses were very scattered. The most frequent response – more than 40% each for "best" and "worst" aspects of plan – was admission that respondents did not know or needed more information.

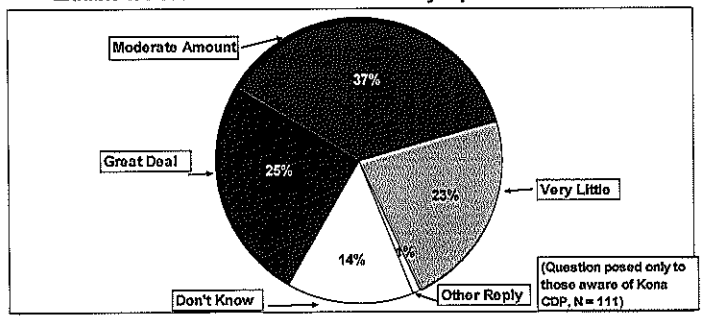
Exhibit 3: "Best Parts" and "Worst Parts" of Kona CDP

Best Parts		Worst Parts	
more roads/traffic alleviation	14%	no action will really be taken	10%
good plan/like the plan	13%	too much development	5%
puts everything in one area	7%	poor road plans	5%
more recreational facilities	6%	high cost of development	5%
hospital is needed	5%	increase traffic	4%
preservation of land	5%	will take too long to complete	4%
good location for growth	5%	not enough emphasis on schools	4%
plans for more affordable housing	3%	not enough community input	4%
UH will be there	3%	not a long-term solution	2%
infrastructure included in plan	3%	other	10%
community input	3%	no answer	11%
considers cultural values	2%	DK/Need more info	46%
dev. thoughtfully considered	1%		
creates new jobs	1%		
other	7%		
DK/Need more info	41%		

c. Perceived Extent of Community Input

The 111 respondents aware of the plan were also asked whether they thought there had been a great deal of, moderate amount of, or very little community input to the plan. Exhibit 4 shows overall results. Overall, 25% said "great deal;" 37% said "moderate amount;" 23% said "very little;" and 15% were unsure or gave some other reply.

Exhibit 4: Perceived Extent of Community Input to the Kona CDP



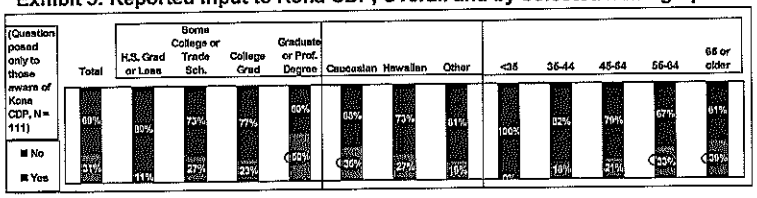
Data in Appendix B show that groups more likely to perceive a "great" amount of input included the more affluent (32%) and/or most educated (40%) respondents. However, due to the small sub-sample sizes, these differences would not technically be statistically significant.

d. Reported Personal Input to the Kona CDP

Finally, the 111 respondents aware of the plan were asked if they had personally gone to any meetings or had any input to the Kona CDP. Exhibit 5 shows overall responses as well as several of the more notable demographic differences (education, ethnicity, and age).

Overall, 31% said they had some input to the plan, and 69% said they had not. (The 31% is based only on those responding to this question; for the overall sample, this would translate to about 9%.) Input was reported by the most educated, Caucasians, and/or older residents, although the small sub-sample sizes meant such differences did not attain statistical significance.

Exhibit 5: Reported Input to Kona CDP, Overall and by Selected Demographics



3. Agreement/Disagreement with Selected Key Kona CDP Planning Principles

The Kona CDP is approximately 275 pages long, and filled with numerous very specific recommendations and requirements. The selected broad principles used in the survey were those which applied to the area specified in the plan as being targeted for most future growth – i.e., the region between Kailua and the airport, including the proposed future side of the Kaloko Makai development.

Interviewers reading Q6 asked: "*I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.*"

Eight key principles were posed for agreement or disagreement. (Because the logic of the principles was sequential in nature, these items did not have a rotating start point but were always asked in the same order.) The questionnaire wording for these items inevitably was boiled down and somewhat simplified from the wording in the CDP, but every effort was made to remain true to the underlying principles.

Exhibit 6 shows the overall results for these eight items (though it should be noted the item wording in Exhibit 6 had been further truncated for simplicity in presentation, and the reader should refer to full original wording Appendix A).

Exhibit 6: Agreement with Selected Key CDP Planning Principles

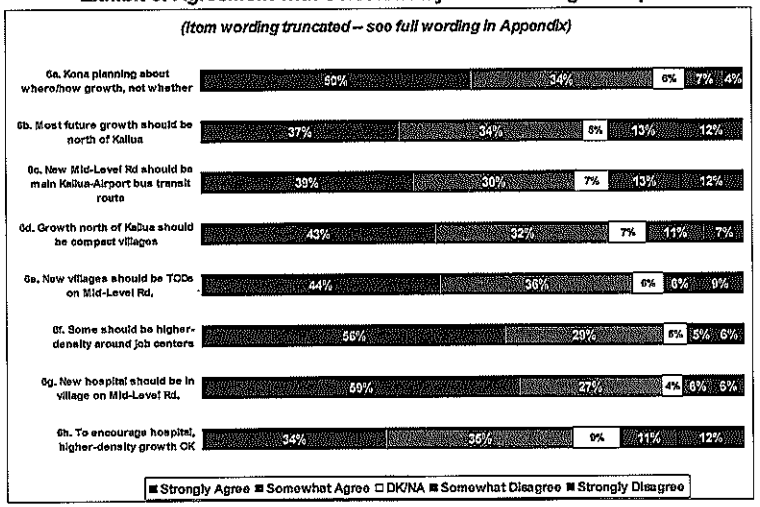


Exhibit 6 shows:

- Strong majorities agreed – either "strongly" or "somewhat" – with all stated Kona CDP planning principles. Disagreement never exceeded 25%.
- The very strongest agreement was with the propositions that (1) at least some new developments should provide higher-density housing and commercial development to support major job centers; and (2) there should be a new hospital along the Mid-Level Road in one of the villages between Kailua and the airport.

Some of the more noteworthy demographic differences of patterns to be observed for this series of items in Appendix B include:

- Although demographic differences could be found for particular items, there was no consistent pattern of differences – e.g., younger people did not usually agree or disagree more often than did older people on the great majority of questions.
- Smaller percentages "strongly agreed" that "*Planning for Kona is mostly about where and how growth happens, not trying to make growth happen faster or slower*" among younger residents, the least educated, Native Hawaiians, and/or lifetime residents. However, most of these groups were simply down-shifting to "somewhat agree," not actively disagreeing.

- There were no significant and/or meaningful differences in regard to agreement with the last two items in Exhibit 6 – i.e., that a new hospital should be built on the Mid-Level Road, and that higher densities should be allowed to attract a hospital site.

4. Awareness of, and Reaction to, Proposed Kaloko Makai Project

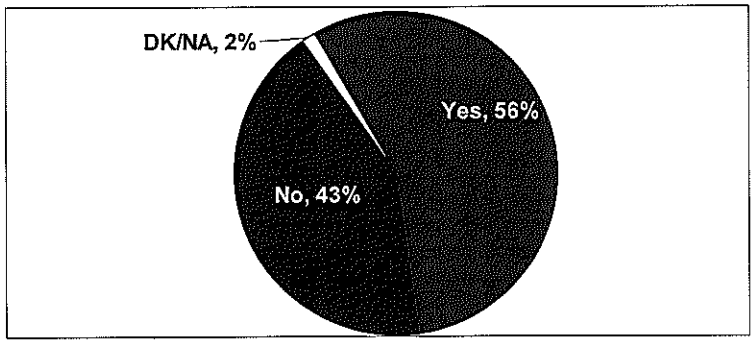
After Q6, immediately following survey questions were:

- Q7: "*Have you heard that a new development is being proposed for the Kaloko Makai area, north and mauka of Costco along Hina Lani Street?*" (Closed-ended: Yes or no?)
- Q8: *"Here's a summary of the proposal, to be developed over 30 years: 5,000 housing units of various types spread over 1,150 acres, one intermediate and two elementary schools, mauka and makai commercial areas, 150-acre dryland forest preserve, and a new regional hospital on the Mid-Level Road. Does this overall package sound like a very acceptable, somewhat acceptable, somewhat unacceptable, or very unacceptable idea?"* (Closed-ended: very acceptable, somewhat acceptable, somewhat unacceptable, or very unacceptable?)
- Q9 [asked only if "acceptable" to Q8]: *"What is the most important reason you think this is an acceptable development?"* (Open-ended?)
- Q10 [asked only if "unacceptable" to Q8]: *"What is the most important reason you think this is an unacceptable development?"* (Open-ended?)

a. Awareness of Kaloko Makai Project

Exhibit 7 shows overall responses to the question about whether the respondent has heard about the project. Overall, 56% said they had heard about the plan; 43% said they had not; and 2% were unsure.

Exhibit 7: Awareness of Kaloko Makai Project

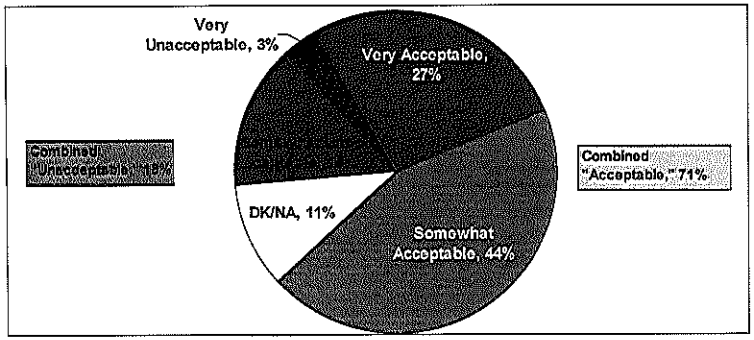


The cross-tabulations in Appendix B show very little difference among demographic groups in response to this question. Young people, homeowners, and higher-income residents were slightly more likely to have heard of the project, but these differences did not pass tests of statistical significance.

b. Acceptability of Proposed Project

As with the question about the Kona CDP, it was necessary to boil down a complex project proposal into a relatively short question (as stated above or in Appendix A). It should be acknowledged that attitudes may change with time and with media attention to specific project aspects. However, Exhibit 8 shows results for this question as of the interview timeframe in spring 2009.

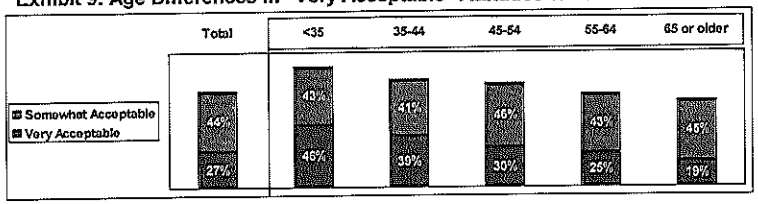
Exhibit 8: Acceptability of Proposed Kaloko Makai Development



Overall, 71% found the project as described to be "acceptable," and 18% found it "unacceptable," with the remainder unsure. Not surprisingly, given the historic mixed feelings over growth in Kona and the Neighbor Islands in general, there were more "somewhat acceptable" than "very acceptable" responses, and also more "somewhat" than "very unacceptable" responses as well.

Detailed cross-tabulations in Appendix B show various small demographic differences, but only one achieved statistical significance – the much greater tendency of people aged 35 or less to find the project "acceptable" as compared to older people, especially senior citizens. Since the sample was biased in a way that under-represented young people, this suggests the true "acceptable" proportion for all North Kona residents would exceed the combined 71% indicated in Exhibits 8 and 9.

Exhibit 9: Age Differences in "Very Acceptable" Attitudes toward Kaloko Makai



c. Reported Reasons for "Acceptable" or "Unacceptable" Responses

Exhibits 10 and 11 show the reasons given by the 185 respondents who had said "acceptable," as well as the 102 respondents who had said "unacceptable." (Note that different respondents answered the different questions. Also, no follow-up question was asked of those who were not sure of the project's acceptability.)

The majority group who found the proposed project acceptable either tended to focus on specific project elements – particularly the hospital site, but also housing, schools, and traffic alleviation via the Mid-Level Road – or just found it a good plan overall. The minority who found the project unacceptable primarily focused on its scale ("too big") or said the available amount of land was not enough for all proposed development elements ("density too high").

The cross-tabulations in Appendix B indicate only minor demographic differences in these responses – e.g., younger residents who found the project "acceptable" tended to talk a little more on the hospital, schools, and job potentials, while older ones talked a little more about housing or the overall sense of it being a good plan.

Exhibit 10: Reasons Kaloko Makai Is "Acceptable" or "Unacceptable"

"Acceptable"		"Unacceptable"	
hospital is needed	36%	too big / don't need	46%
good plan/ meets future needs	26%	density too high	21%
more housing / affordable housing	18%	too much traffic	12%
more schools	15%	not enough infrastructure	12%
alleviate traffic	11%	poor location	8%
increase in jobs	8%	need to preserve land	7%
everything is close proximity	7%	finish other projects first	7%
good location	7%	poor plan	6%
infrastructure for growing population	4%	not enough water	5%
long-term plan	4%	too long to complete	5%
good use of unused land	4%	not enough schools	4%
preservation of land considered	2%	other	11%
other	8%	DK/Need more info	1%
DK/Need more info	2%		

Appendix A:

Survey Questionnaire and Overall Results

2009 North Kona Community Survey

Reference No._____
Time Ended _____
Time Started_____
Total Minutes_____
Interviewer ID_____
Telephone_____

Date:_____
Interviewer Name_____
Respondent Name_____

Hello, good morning/afternoon/evening, I'm _____ from FAQ Hawai'i, a professional survey research center in Honolulu. Today we're conducting a short survey on residents' attitudes on public issues in North Kona. Let me assure you this survey is to get your opinions only, and we're not selling anything. Let me also assure you that all of your answers will be kept completely confidential.

A. Are you a full-time Kona resident who is 18 years of age or older?
YES ← CONTINUE
NO ← TERMINATE

1. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all. **[ROTATE]**:

		Very Important	Fairly Important	Somewhat Important	Not Important at All	DK/NA
a.	more beach or coastal parks	44.50%	22.00%	20.50%	11.75%	1.25%
b.	more roads connecting mauka and makai areas	73.25%	11.25%	8.75%	5.00%	1.75%
c.	a new hospital in North Kona	74.75%	8.75%	8.50%	7.50%	0.50%
d.	more new housing units affordable to the average Kona family	65.50%	14.00%	9.75%	8.75%	2.00%
e.	preservation of open spaces between new urban developments	60.00%	18.75%	14.00%	5.50%	1.75%
f.	more tourism jobs	40.75%	22.50%	20.00%	12.75%	4.00%
g.	faster development of Hawaiian Home Lands areas	35.75%	16.50%	20.50%	17.75%	9.50%
h.	more doctors and medical personnel	90.25%	5.00%	2.25%	1.50%	1.00%
i.	more buses serving the North Kona area	51.25%	18.25%	16.50%	8.00%	6.00%
j.	more active sports playing fields	40.25%	20.75%	20.50%	13.25%	5.25%
k.	more elementary and intermediate schools	34.00%	17.75%	16.75%	15.00%	16.50%
l.	developing a Mid-Level road mauka of Queen Ka'ahumanu Highway and makai of Mamalahoa Highway, in between and parallel to both of them	56.00%	13.75%	13.25%	13.75%	3.25%

2. Have you read or heard that the County just approved a new Kona Community Development Plan?

Yes.....27.75%
No.....70.75% → GO TO Q6
(Don't know/no answer).....1.50%

3. From what you have read or heard, what do you think are the best parts of this new plan? **[RECORD ANSWERS VERBATIM.]**

[See summary of coded results in Exhibit 3 of foregoing report.]

4. From what you have read or heard, what are the worst parts of the plan, or what worries you about it? **[RECORD ANSWERS VERBATIM.]**

[See summary of coded results in Exhibit 3 of foregoing report.]

5. Do you believe this plan was based on what you would call a great deal of community input, a moderate amount of community input, or very little community input?

Great deal of community	25.23%
Moderate amount of community input	36.94%
Very little community input	22.52%
(Other reply)	0.90%
(Don't know/no answer)	14.41%

5a. Did you personally go to any meetings or have any input to this plan?

Yes	30.63%
No	69.37%
(Don't know/no answer)	0.00%

6. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan. **[READ IN ORDER]**

		Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	DK/NA
a.	Planning for Kona is mostly about where and how growth happens, not trying to make growth happen faster or slower.	49.75%	33.75%	7.00%	3.50%	6.00%
b.	Most future growth should be located north of Kailua, toward the airport.	36.50%	34.00%	13.25%	11.50%	4.75%
c.	The new Mid-Level Road should be developed as the main route for buses or other future mass transit connecting Kailua to the Airport.	39.00%	30.00%	13.00%	11.50%	6.50%
d.	Growth north of Kona should be directed mostly into compact mixed-use villages, with open space in between them.	43.00%	32.25%	10.75%	7.00%	7.00%
e.	The new villages should be centered around bus transit stops on the new Mid-Level Road.	44.00%	35.75%	5.75%	8.75%	5.75%
f.	Some villages should provide higher-density housing and commercial to support major job areas like the civic center, new hospital, and new university.	56.00%	29.25%	4.75%	5.50%	4.50%
g.	There should be a new hospital along the Mid-Level Road in one of the villages between Kailua and the airport.	58.50%	26.50%	5.50%	5.75%	3.75%
h.	To encourage a private landowner to attract a new hospital site, higher densities should be allowed in that village.	33.75%	34.75%	10.50%	12.25%	8.75%

7. Have you heard that a new development is being proposed for the Kaloko Makai area, north and mauka of Costco along Hina Lani Street?

Yes	56.00%
No	42.50%
(Don't know/no answer)	1.50%

8. Here's a summary of the proposal, to be developed over 30 years: 5,000 housing units of various types spread over 1,150 acres, one intermediate and two elementary schools, mauka and makai commercial areas, 150-acre dryland forest preserve, and a new regional hospital on the Mid-Level Road. Does this overall package sound like a very acceptable, somewhat acceptable, somewhat unacceptable, or very unacceptable idea?

Very acceptable	27.25%	→ ASK Q9
Somewhat acceptable	44.00%	
Somewhat unacceptable	10.75%	→ ASK Q10
Very unacceptable	14.75%	
(Don't know/no answer)	3.25%	→ GO TO Q11

9. What is the most important reason you think this is an acceptable development? **[RECORD ANSWERS VERBATIM, THEN GO TO Q 11.]**

[See summary of coded results in Exhibit 10 of foregoing report.]

10. What is the most important reason you think this is an unacceptable development? **[RECORD ANSWERS VERBATIM.]**

[See summary of coded results in Exhibit 10 of foregoing report.]

11. The rest of our questions are for statistical purposes only.

In which age category are you?	Under 25	2.75%
	25 to 34	4.25%
	35 to 44	11.00%
	45 to 54	20.00%
	55 to 64	31.75%
	65 or older	30.25%
	[Refused]	0.00%
12. What is your ethnic identification? [IF MORE THAN ONE:] With which do you identify the most?	Caucasian	61.50%
	Filipino	4.50%
	Hawaiian or part-Hawaiian	14.00%
	Japanese	7.50%
	Mixed, non-Hawaiian	3.50%
	Other (specify:) _____	6.75%
	[Refused]	2.25%
13. How long have you lived in Hawai'i?	Less than 5 years	9.00%
	5 to 10 years	16.00%
	11 to 20 years	13.00%
	20 years or more	32.25%
	All your life	29.75%
	[Refused]	0.00%
14. Do you own or rent the place where you're living? [COUNT LEASEHOLD AS OWNERSHIP]	Own	78.50%
	Rent	17.75%
	[Refused]	3.75%

15.	Which of the following categories describes your current level of education?	Less than high school ..... 2.50% High school graduate ..... 16.75% Some college or trade school .....32.25% College graduate .....29.75% Graduate or professional degree .....18.75% [Refused] 0.00%
16.	Which of the following categories includes your total annual family income before taxes for 2008? Just stop me when I reach the correct category.	Less than $25,000 .....10.25% $25,000 but less than $35,000 .....9.50% $35,000 but less than $50,000 .....14.50% $50,000 but less than $75,000 .....17.75% $75,000 but less than $100,000 .....16.00% $100,000 and over .....16.25% [Refused] 15.75%
17.	Gender [RECORD, DO NOT ASK]	Male .....41.50% Female 58.50%

In case my supervisor would like to verify this survey, may I have just your first name please? [RECORD RESPONDENT NAME ON COVER.] And that was my last question. Thank you very much for your time and cooperation in completing this survey!

Appendix B:

Demographic Cross-Tabulations

Q1c. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
A NEW HOSPITAL IN NORTH KONA.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
NEW HOSPITAL	very important	75%	65%	77%	76%	77%	71%	72%	82%	78%	71%	85%	72%	76%
	fairly important	9%	11%	9%	10%	5%	12%	10%	4%	10%	11%	4%	10%	8%
	somewhat important	9%	11%	7%	9%	7%	10%	9%	4%	9%	6%	6%	11%	7%
	not at all important	6%	11%	7%	4%	10%	7%	9%	11%	3%	9%	4%	7%	6%
	DK/NA	1%	0%	0%	0%	1%	1%	0%	0%	1%	1%	0%	0%	1%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1d. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE NEW HOUSING UNITS AFFORDABLE TO THE AVERAGE KONA FAMILY.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE NEW AFFORDABLE HSNG	very important	66%	71%	61%	74%	65%	60%	61%	64%	66%	60%	71%	61%	72%
	fairly important	14%	18%	14%	9%	13%	17%	16%	4%	17%	16%	12%	14%	13%
	somewhat important	10%	4%	14%	10%	11%	8%	13%	4%	7%	11%	6%	16%	3%
	not at all important	9%	4%	9%	8%	9%	11%	8%	9%	9%	10%	6%	9%	9%
	DK/NA	2%	4%	2%	0%	2%	3%	3%	0%	1%	3%	4%	1%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1a. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE BEACH OR COASTAL PARKS.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE BEACHES/ COASTAL PARKS	very important	45%	43%	50%	53%	44%	36%	44%	46%	44%	34%	37%	53%	48%
	fairly important	22%	29%	15%	25%	21%	21%	21%	36%	16%	22%	23%	19%	25%
	somewhat important	21%	14%	20%	15%	24%	22%	22%	13%	21%	30%	23%	16%	16%
	not at all important	12%	14%	11%	6%	10%	16%	11%	6%	16%	14%	13%	11%	10%
	DK/NA	1%	0%	0%	0%	1%	3%	2%	0%	1%	0%	4%	2%	1%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1b. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE ROADS CONNECTING MAUKA AND MAKAI AREAS.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE ROADS CONNECTING MAUKA & MAKAI	very important	73%	57%	66%	80%	72%	76%	73%	73%	74%	70%	75%	74%	74%
	fairly important	11%	21%	14%	13%	6%	11%	11%	7%	15%	16%	15%	10%	7%
	somewhat important	9%	7%	11%	6%	11%	7%	10%	7%	4%	9%	6%	10%	8%
	not at all important	5%	11%	7%	1%	7%	3%	4%	9%	6%	3%	2%	4%	9%
	DK/NA	2%	4%	2%	0%	2%	2%	2%	4%	1%	2%	0%	2%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1g. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
FASTER DEVELOPMENT OF HAWAIIAN HOME LANDS AREAS.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
FASTER DEV. OF HAWN HOME LANDS	very important	36%	39%	52%	36%	34%	31%	31%	61%	35%	29%	25%	33%	43%
	fairly important	17%	36%	11%	18%	17%	13%	15%	21%	19%	7%	17%	22%	18%
	somewhat important	21%	18%	25%	28%	18%	17%	22%	11%	22%	25%	33%	18%	14%
	not at all important	18%	4%	9%	16%	20%	23%	22%	7%	11%	26%	17%	18%	12%
	DK/NA	10%	4%	2%	3%	12%	16%	10%	0%	12%	11%	8%	12%	7%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1h. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE DOCTORS AND MEDICAL PERSONNEL.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE DOCTORS/MED. STAFF	very important	90%	82%	86%	95%	90%	91%	90%	91%	89%	90%	94%	88%	91%
	fairly important	5%	7%	11%	4%	6%	2%	4%	5%	7%	6%	4%	4%	6%
	somewhat important	2%	7%	2%	1%	3%	1%	2%	4%	1%	1%	2%	4%	2%
	not at all important	2%	0%	0%	0%	2%	3%	2%	0%	2%	1%	0%	4%	0%
	DK/NA	1%	4%	0%	0%	0%	2%	1%	0%	1%	2%	0%	0%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1e. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
PRESERVATION OF OPEN SPACES BETWEEN NEW URBAN DEVELOPMENTS.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
PRESERVATION OF OPEN SPACES	very important	60%	43%	64%	65%	63%	56%	64%	61%	47%	50%	60%	69%	59%
	fairly important	19%	29%	14%	21%	16%	20%	16%	21%	25%	21%	23%	15%	19%
	somewhat important	14%	14%	16%	11%	13%	16%	13%	11%	21%	17%	15%	12%	13%
	not at all important	6%	7%	7%	3%	6%	6%	7%	2%	4%	11%	0%	4%	5%
	DK/NA	2%	7%	0%	0%	2%	2%	1%	5%	2%	1%	2%	1%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1f. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE TOURISM JOBS.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE TOURISM JOBS	very important	41%	43%	45%	48%	35%	40%	37%	45%	49%	47%	29%	38%	44%
	fairly important	23%	21%	25%	23%	20%	25%	23%	18%	26%	21%	29%	21%	23%
	somewhat important	20%	14%	20%	19%	24%	17%	22%	18%	16%	23%	27%	19%	18%
	not at all important	13%	14%	7%	10%	17%	12%	15%	16%	4%	7%	13%	18%	12%
	DK/NA	4%	7%	2%	1%	4%	6%	4%	4%	4%	2%	2%	5%	6%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1k. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE ELEMENTARY AND INTERMEDIATE SCHOOLS.

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE ELE. & MIDDLE SCHOOLS	very important	34%	50%	48%	44%	25%	28%	30%	34%	44%	36%	37%	29%	38%
	fairly important	18%	14%	16%	16%	20%	17%	18%	16%	18%	16%	10%	22%	18%
	somewhat important	17%	11%	23%	14%	23%	12%	16%	20%	17%	12%	17%	18%	19%
	not at all important	15%	25%	9%	15%	15%	15%	13%	27%	10%	11%	13%	15%	19%
	DK/NA	17%	0%	5%	11%	17%	28%	22%	4%	11%	25%	23%	16%	7%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	245	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1l. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
DEVELOPING A MID-LEVEL ROAD MAUKA OR QUEEN KA'AHUMANU HIGHWAY AND MAKAI OF MAMALAHOA HIGHWAY, IN BETWEEN AND PARALLEL TO BOTH OF THEM.

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
DEVELOPING MID-LEVEL ROAD	very important	56%	50%	43%	65%	50%	62%	56%	54%	57%	60%	52%	66%	55%
	fairly important	14%	21%	20%	14%	10%	13%	13%	16%	17%	16%	23%	9%	13%
	somewhat important	13%	11%	16%	10%	18%	10%	12%	14%	16%	10%	13%	16%	13%
	not at all important	14%	16%	16%	9%	18%	11%	16%	13%	6%	7%	10%	18%	17%
	DK/NA	3%	0%	5%	3%	3%	4%	4%	4%	2%	7%	2%	2%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	245	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1i. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE BUSES SERVING THE NORTH KONA AREA.

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE BUSES	very important	51%	36%	52%	58%	49%	53%	50%	45%	61%	45%	60%	49%	55%
	fairly important	18%	21%	20%	19%	17%	18%	20%	20%	13%	13%	25%	22%	16%
	somewhat important	17%	21%	11%	15%	22%	12%	18%	15%	12%	16%	10%	19%	15%
	not at all important	8%	14%	14%	5%	6%	6%	7%	11%	6%	13%	4%	5%	8%
	DK/NA	6%	7%	2%	4%	6%	6%	7%	4%	6%	11%	2%	5%	5%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	245	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1j. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE ACTIVE SPORTS PLAYING FIELDS.

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MORE ACTIVE SPORTS FIELDS	very important	40%	57%	52%	51%	31%	35%	34%	54%	51%	29%	35%	40%	53%
	fairly important	21%	11%	23%	20%	22%	21%	24%	16%	15%	22%	25%	23%	15%
	somewhat important	21%	14%	18%	20%	25%	18%	22%	14%	21%	23%	21%	19%	19%
	not at all important	13%	16%	5%	6%	17%	17%	14%	13%	10%	16%	8%	16%	10%
	DK/NA	5%	0%	2%	3%	6%	9%	7%	2%	3%	10%	12%	2%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	245	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q4. From what you have read or heard, what are the worst parts of the plan, or what worries you about it?

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
Q4: Worst Parts of this Plan	DK/Need more info	46%	75%	27%	42%	45%	50%	49%	36%	38%	47%	45%	55%	33%
	No answer	11%	0%	0%	16%	10%	13%	8%	27%	10%	12%	0%	10%	17%
	no action will be taken	10%	0%	9%	16%	10%	8%	13%	0%	5%	7%	23%	13%	4%
	other	9%	0%	36%	0%	10%	5%	12%	0%	5%	12%	15%	6%	4%
	too much development	5%	0%	0%	5%	8%	3%	4%	9%	5%	2%	0%	3%	13%
	poor road plans	5%	25%	0%	5%	8%	0%	4%	9%	5%	7%	0%	3%	4%
	high cost of development	5%	0%	9%	5%	3%	5%	6%	0%	0%	9%	0%	3%	0%
	increase traffic	4%	0%	9%	11%	3%	0%	1%	9%	10%	5%	0%	3%	4%
	will take too long to complete	4%	0%	0%	5%	0%	8%	3%	9%	5%	2%	8%	0%	8%
	not enough emphasis on schools	4%	0%	9%	0%	3%	5%	4%	0%	5%	5%	8%	3%	0%
	not enough community input	4%	0%	0%	0%	5%	5%	3%	0%	10%	0%	0%	6%	8%
	not a long-term solution	2%	0%	0%	0%	3%	3%	0%	9%	5%	0%	0%	0%	8%
BASE		111	4	11	19	39	38	77	11	21	43	13	31	24

FAQ Hawaii, Inc. (2009)

Q5. Do you believe this plan was based on what you would call a great deal of community input, a moderate amount of community input, or very little community input?

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
AMOUNT OF COMMUNITY INPUT ON PLAN	great deal of community input	25%	0%	27%	16%	36%	21%	26%	9%	33%	30%	23%	23%	21%
	moderate amount of community input	37%	25%	36%	32%	31%	47%	38%	18%	43%	30%	38%	52%	29%
	very little community input	23%	75%	18%	21%	28%	13%	23%	36%	14%	28%	31%	10%	25%
	other	1%	0%	0%	0%	0%	3%	0%	9%	0%	0%	0%	0%	4%
	DK/NA	14%	0%	18%	32%	5%	16%	13%	27%	10%	12%	8%	16%	21%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		111	4	11	19	39	38	77	11	21	43	13	31	24

FAQ Hawaii, Inc. (2009)

Q2. Have you read or heard that the County just approved a new Kona Community Development Plan?

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
HEARD THAT COUNTY APPROVED NEW KONA COMM. DEV. PLAN	yes	28%	14%	25%	24%	31%	31%	31%	20%	24%	43%	25%	24%	20%
	no	71%	86%	75%	74%	68%	67%	67%	80%	74%	57%	69%	74%	79%
	DK/NA	2%	0%	0%	3%	2%	2%	2%	0%	2%	0%	6%	2%	1%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	83	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q3. From what you have read or heard, what do you think are the best parts of this new plan?

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
Q3: Best Parts of this Plan	DK/Need more info	41%	75%	27%	42%	49%	34%	33%	45%	62%	35%	31%	48%	50%
	more roads / traffic alleviation	14%	0%	9%	5%	10%	24%	14%	9%	14%	16%	15%	10%	13%
	good plan/like the plan	13%	0%	18%	21%	10%	11%	12%	18%	10%	21%	8%	3%	13%
	puts everything in one area	7%	0%	18%	11%	8%	3%	9%	0%	5%	7%	8%	13%	0%
	other	7%	0%	0%	11%	8%	8%	5%	27%	5%	7%	8%	3%	13%
	more recreational facilities	6%	0%	9%	0%	5%	11%	8%	0%	5%	7%	8%	10%	0%
	hospital is needed	5%	0%	9%	0%	0%	13%	3%	0%	19%	5%	0%	10%	4%
	preservation of land	5%	0%	9%	0%	5%	5%	5%	0%	5%	5%	0%	6%	4%
	good location	5%	0%	9%	0%	3%	8%	5%	9%	0%	2%	23%	0%	4%
	more affordable hsng	3%	0%	0%	0%	0%	8%	3%	9%	0%	2%	0%	3%	4%
	UH will be there	3%	25%	0%	0%	5%	0%	3%	0%	5%	5%	8%	0%	0%
	infrastructure included in plan	3%	0%	0%	11%	3%	0%	4%	0%	0%	2%	0%	6%	0%
	community input	3%	0%	0%	5%	3%	3%	4%	0%	0%	0%	15%	3%	0%
	considers cultural values	2%	0%	0%	5%	3%	0%	3%	0%	0%	0%	0%	6%	0%
	dev. thoughtfully considered	1%	0%	0%	0%	3%	0%	1%	0%	0%	0%	0%	3%	0%
	creates new jobs	1%	0%	9%	0%	0%	0%	1%	0%	0%	0%	0%	0%	4%
	don't like new developments	1%	0%	0%	0%	0%	3%	1%	0%	0%	0%	0%	0%	4%
BASE		111	4	11	19	39	38	77	11	21	43	13	31	24

FAQ Hawaii, Inc. (2009)

Q6b. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
MOST FUTURE GROWTH SHOULD BE LOCATED NORTH OF KAILUA, TOWARD THE AIRPORT.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MOST FUTURE GROWTH SHOULD BE NORTH OF KAILUA	strongly agree	37%	43%	39%	38%	33%	34%	36%	34%	42%	39%	40%	35%	34%
	somewhat agree	34%	32%	45%	36%	30%	33%	31%	43%	36%	31%	42%	29%	39%
	somewhat disagree	13%	14%	7%	13%	13%	16%	14%	13%	10%	16%	8%	14%	13%
	strongly disagree	12%	4%	9%	9%	15%	12%	13%	11%	7%	7%	4%	18%	12%
	DK/NA	5%	7%	0%	5%	6%	5%	6%	0%	6%	7%	6%	5%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	88	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q6c. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
THE NEW MID-LEVEL ROAD SHOULD BE DEVELOPED AS THE MAIN ROUTE FOR BUSES OR OTHER FUTURE MASS TRANSIT CONNECTING KAILUA TO THE AIRPORT.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
MID-LEVEL ROAD SHOULD BE MAIN KAILUA-AIRPORT BUS TRANSIT ROUTE	strongly agree	39%	32%	36%	53%	32%	40%	37%	32%	51%	40%	52%	36%	35%
	somewhat agree	30%	36%	36%	20%	29%	34%	29%	41%	26%	28%	33%	26%	35%
	somewhat disagree	13%	18%	9%	15%	13%	12%	15%	14%	9%	12%	6%	16%	14%
	strongly disagree	12%	11%	16%	8%	17%	7%	11%	13%	8%	13%	4%	16%	9%
	DK/NA	7%	4%	2%	5%	9%	7%	8%	0%	7%	7%	6%	7%	6%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	88	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q5a. Did you personally go to any meetings or have any input to this plan?

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
PERSONALLY GO TO MEETINGS ABOUT PLAN	yes	31%	0%	18%	21%	33%	39%	35%	27%	19%	30%	31%	32%	29%
	no	69%	100%	82%	79%	67%	61%	65%	73%	81%	70%	69%	68%	71%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		111	4	11	19	33	38	77	11	21	43	13	31	24

FAQ Hawaii, Inc. (2009)

Q6a. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
PLANNING FOR KONA IS MOSTLY ABOUT WHERE AND HOW GROWTH HAPPENS, NOT TRYING TO MAKE GROWTH HAPPEN FASTER OR SLOWER.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
PLANNING FOR KONA IS MOSTLY WHERE/HOW GROWTH HAPPENS	strongly agree	50%	29%	52%	53%	50%	51%	54%	32%	51%	60%	45%	52%	35%
	somewhat agree	34%	57%	32%	23%	38%	32%	34%	34%	33%	29%	37%	35%	35%
	somewhat disagree	7%	11%	7%	14%	4%	5%	4%	20%	6%	5%	6%	3%	13%
	strongly disagree	4%	0%	5%	3%	4%	4%	4%	7%	0%	2%	4%	5%	3%
	DK/NA	6%	4%	5%	9%	4%	7%	4%	7%	11%	4%	6%	5%	8%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	88	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q6f. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
SOME VILLAGES SHOULD PROVIDE HIGHER-DENSITY HOUSING AND COMMERCIAL TO SUPPORT MAJOR JOB AREAS LIKE THE CIVIC CENTER, NEW HOSPITAL, AND NEW UNIVERSITY.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
SOME VILLAGES SHOULD PROVIDE HIGH DENSITY HOUSING	strongly agree	56%	64%	57%	56%	51%	59%	57%	45%	63%	63%	69%	50%	50%
	somewhat agree	29%	25%	34%	29%	35%	23%	28%	43%	22%	23%	25%	33%	33%
	somewhat disagree	5%	4%	7%	5%	5%	4%	5%	2%	3%	4%	2%	7%	4%
	strongly disagree	6%	4%	0%	4%	7%	7%	7%	7%	1%	7%	2%	5%	6%
	DK/NA	5%	4%	2%	6%	2%	7%	3%	2%	10%	3%	2%	5%	7%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q6g. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
THERE SHOULD BE A NEW HOSPITAL ALONG THE MID-LEVEL ROAD IN ONE OF THE VILLAGES BETWEEN KAILUA AND THE AIRPORT.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
SHOULD BE NEW HOSPITAL AROUND MID-LEVEL ROAD	strongly agree	58%	71%	64%	63%	53%	57%	57%	57%	65%	58%	65%	57%	57%
	somewhat agree	27%	18%	23%	28%	30%	26%	25%	27%	27%	24%	21%	28%	29%
	somewhat disagree	6%	0%	9%	6%	6%	4%	6%	11%	1%	4%	8%	6%	5%
	strongly disagree	6%	7%	0%	3%	8%	7%	6%	4%	2%	7%	4%	6%	5%
	DK/NA	4%	4%	5%	1%	3%	6%	4%	2%	4%	7%	2%	2%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q6d. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
GROWTH NORTH OF KONA SHOULD BE DIRECTED MOSTLY INTO COMPACT MIXED-USE VILLAGES, WITH OPEN SPACE IN BETWEEN THEM.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
GROWTH N. OF KONA SHOULD BE INTO COMPACT MIXED-USE	strongly agree	43%	36%	36%	50%	40%	45%	45%	36%	42%	45%	44%	45%	39%
	somewhat agree	32%	43%	39%	28%	34%	29%	31%	30%	39%	30%	42%	35%	27%
	somewhat disagree	11%	7%	18%	10%	10%	11%	10%	21%	6%	13%	6%	5%	17%
	strongly disagree	7%	7%	5%	6%	11%	4%	7%	9%	2%	6%	6%	9%	7%
	DK/NA	7%	7%	5%	6%	5%	11%	7%	4%	11%	6%	2%	6%	11%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q6a. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
THE NEW VILLAGES SHOULD BE CENTERED AROUND BUS TRANSIT STOPS ON THE NEW MID-LEVEL ROAD.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
NEW VILLAGES SHOULD BE CENTERED AROUND TRANSIT STOPS	strongly agree	44%	29%	43%	45%	45%	46%	45%	33%	46%	44%	67%	42%	36%
	somewhat agree	36%	50%	36%	39%	31%	36%	35%	39%	36%	40%	23%	36%	37%
	somewhat disagree	6%	4%	11%	3%	6%	6%	7%	6%	4%	4%	2%	7%	8%
	strongly disagree	9%	4%	7%	10%	14%	4%	8%	11%	7%	8%	4%	10%	10%
	DK/NA	6%	14%	2%	4%	4%	8%	6%	5%	7%	4%	4%	5%	9%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q8. Here's a summary of the proposal, to be developed over 30 years: 5,000 housing units of various types spread over 1,150 acres, one intermediate and two elementry schools, mauka and makai commercial areas, 150-acre dryland forest preserve, and a new regional hospital on the Mid-Level Road. Does this overall package sound like a very acceptable, somewhat acceptable, somewhat unacceptable, or very unacceptable idea?

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
PACKAGE SOUND GOOD?	very acceptable	27%	46%	39%	30%	25%	19%	24%	29%	36%	32%	29%	22%	28%
	somewhat acceptable	44%	43%	41%	46%	43%	45%	43%	52%	42%	41%	52%	40%	43%
	somewhat unacceptable	11%	4%	14%	10%	9%	14%	14%	4%	7%	9%	12%	16%	7%
	very unacceptable	15%	4%	7%	9%	22%	17%	17%	13%	8%	16%	6%	19%	13%
	DK/NA	3%	4%	0%	5%	1%	6%	2%	4%	8%	2%	2%	3%	5%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q9. What is the most important reason you think this is an acceptable development?

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
Q9. Most important reason you think development is acceptable.	hospital is needed	36%	43%	40%	33%	37%	32%	35%	44%	38%	34%	43%	34%	37%
	good plan/ meets future needs	26%	16%	29%	25%	24%	30%	25%	16%	30%	25%	24%	33%	21%
	more housing / affordable housing	16%	12%	9%	13%	14%	25%	15%	24%	14%	16%	14%	9%	21%
	more schools	15%	26%	23%	16%	11%	12%	11%	16%	25%	14%	19%	14%	17%
	alleviate traffic	11%	4%	11%	11%	13%	12%	12%	9%	13%	12%	14%	14%	7%
	increase in jobs	8%	26%	3%	10%	6%	6%	6%	16%	10%	7%	5%	5%	14%
	other	8%	8%	6%	7%	7%	10%	7%	13%	7%	5%	5%	6%	12%
	everything is close proximity	7%	8%	3%	11%	5%	4%	7%	11%	6%	7%	7%	5%	10%
	good location	7%	0%	6%	7%	13%	3%	6%	4%	6%	5%	2%	13%	4%
	infrastructure for growing pop.	4%	4%	3%	3%	5%	3%	5%	0%	1%	3%	12%	3%	1%
	long-term plan	4%	4%	3%	7%	1%	4%	2%	4%	6%	3%	6%	3%	4%
	good use of unused land	4%	0%	6%	3%	3%	4%	4%	2%	3%	4%	2%	5%	2%
	preservation of land considered	2%	0%	0%	10%	1%	0%	4%	0%	1%	3%	7%	3%	0%
	DK/Need more info	2%	4%	0%	2%	2%	1%	3%	0%	0%	4%	2%	1%	0%
BASE		285	25	35	61	87	77	164	45	65	73	42	80	90

FAQ Hawaii, Inc. (2009)

Q6h. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
TO ENCOURAGE A PRIVATE LANDOWNER TO ATTRACT A NEW HOSPITAL SITE, HIGHER DENSITIES SHOULD BE ALLOWED IN THAT VILLAGE.

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
HIGHER DENSITIES TO ATTRACT NEW HOSPITAL/LANDOWNER	strongly agree	34%	36%	27%	43%	36%	27%	33%	25%	44%	39%	29%	36%	29%
	somewhat agree	35%	43%	57%	30%	28%	35%	35%	41%	31%	28%	50%	33%	36%
	somewhat disagree	11%	4%	9%	8%	13%	12%	10%	11%	9%	12%	10%	11%	9%
	strongly disagree	12%	7%	5%	11%	15%	14%	15%	13%	6%	12%	6%	14%	13%
	DK/NA	9%	11%	2%	9%	6%	12%	8%	11%	10%	9%	6%	7%	12%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q7. Have you heard that a new development is being proposed for the Kaloko Makai area, north and mauka of Costco along Hina Lani street?

			AGE					ETHNICITY			LENGTH OF RESIDENCY			
		Total	<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
HEARD OF NEW DEVELOPMENT IN KALOKO MAKAI AREA	yes	56%	56%	45%	55%	57%	56%	57%	54%	53%	57%	60%	52%	58%
	no	43%	25%	50%	45%	41%	44%	41%	46%	45%	41%	33%	47%	40%
	DK/NA	2%	7%	5%	0%	2%	0%	2%	0%	2%	2%	2%	1%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	28	44	80	127	121	246	56	89	100	52	129	119

FAQ Hawaii, Inc. (2009)

Q1a. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE BEACH OR COASTAL PARKS.

		Total	EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
			up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
MORE BEACHES/ COASTAL PARKS	very important	45%	52%	50%	41%	33%	47%	52%	46%	39%	42%	43%	49%	44%	45%
	fairly important	22%	17%	26%	24%	19%	19%	17%	25%	33%	12%	23%	18%	22%	22%
	somewhat important	21%	16%	16%	23%	29%	18%	16%	23%	19%	29%	21%	17%	23%	19%
	not at all important	12%	16%	7%	11%	17%	15%	14%	4%	9%	14%	11%	14%	10%	13%
	DK/NA	1%	0%	2%	2%	1%	1%	2%	1%	0%	3%	1%	1%	1%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	123	119	79	79	68	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1b. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE ROADS CONNECTING MAUKA AND MAKAI AREAS.

		Total	EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
			up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
MORE ROADS CONNECTING MAUKA & MAKAI	very important	73%	75%	75%	71%	71%	75%	66%	70%	84%	66%	75%	72%	76%	71%
	fairly important	11%	10%	9%	13%	13%	8%	16%	13%	6%	15%	11%	7%	10%	12%
	somewhat important	9%	3%	12%	9%	9%	9%	9%	11%	5%	14%	8%	10%	7%	10%
	not at all important	5%	9%	4%	4%	4%	8%	9%	4%	5%	3%	4%	8%	5%	5%
	DK/NA	2%	3%	0%	3%	3%	1%	2%	1%	0%	0%	1%	3%	2%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	123	119	79	79	68	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q10. What is the most important reason you think this is an unacceptable development?

		Total	AGE					ETHNICITY			LENGTH OF RESIDENCY			
			<35 years	35-44	45-54	55-64	65+	Caucasian	Hawaiian	other	up to 10 years	11-20 years	20 years or more	all my life
Q10: Most important reason you think development is unacceptable.	too big / don't need	46%	50%	33%	53%	44%	43%	43%	56%	62%	24%	44%	53%	57%
	density too high	21%	50%	44%	13%	26%	11%	16%	33%	23%	16%	0%	22%	30%
	too much traffic	12%	0%	0%	7%	15%	14%	10%	22%	15%	16%	0%	11%	13%
	not enough infrastructure	12%	0%	11%	13%	15%	8%	12%	11%	8%	20%	22%	7%	9%
	other	11%	0%	0%	13%	10%	14%	12%	0%	15%	8%	44%	7%	9%
	poor location	6%	0%	0%	0%	10%	11%	10%	0%	0%	8%	0%	13%	0%
	need to preserve land	7%	50%	11%	7%	5%	5%	6%	11%	8%	12%	22%	0%	9%
	finish other projects first	7%	0%	0%	13%	10%	3%	6%	11%	8%	4%	11%	7%	9%
	poor plan	6%	50%	0%	7%	5%	5%	8%	0%	0%	4%	0%	9%	4%
	not enough water	5%	0%	11%	0%	5%	5%	3%	22%	8%	0%	11%	2%	13%
	too long to complete	5%	0%	0%	0%	8%	5%	5%	0%	0%	8%	11%	4%	0%
	not enough schools	4%	0%	22%	7%	3%	0%	4%	11%	0%	8%	11%	2%	0%
	DK/Need more info	1%	0%	0%	0%	0%	3%	1%	0%	0%	4%	0%	0%	0%
BASE		102	2	9	15	39	37	77	9	13	25	9	45	23

FAQ Hawaii, Inc. (2009)

Q1e. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
PRESERVATION OF OPEN SPACES BETWEEN NEW URBAN DEVELOPMENTS.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
PRESERVATION OF OPEN SPACES	very important	60%	51%	65%	61%	60%	63%	74%	51%	58%	69%	59%	63%	56%	63%
	fairly important	19%	25%	15%	18%	20%	14%	10%	25%	23%	14%	18%	21%	20%	18%
	somewhat important	14%	14%	15%	13%	15%	14%	12%	18%	14%	12%	15%	10%	16%	12%
	not at all important	6%	6%	3%	8%	5%	5%	0%	4%	5%	5%	6%	1%	6%	5%
	DK/NA	2%	4%	2%	1%	0%	4%	3%	1%	0%	0%	1%	4%	1%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009).

Q1f. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE TOURISM JOBS.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
MOER TOURISM JOBS	very important	41%	53%	39%	33%	36%	53%	34%	39%	42%	34%	40%	45%	39%	42%
	fairly important	23%	17%	25%	24%	23%	19%	19%	27%	22%	23%	24%	18%	21%	24%
	somewhat important	20%	13%	18%	24%	24%	13%	28%	17%	23%	23%	19%	21%	23%	18%
	not at all important	13%	9%	15%	12%	15%	9%	17%	15%	11%	18%	13%	10%	13%	12%
	DK/NA	4%	8%	4%	3%	3%	6%	2%	1%	2%	2%	4%	6%	3%	5%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1c. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
A NEW HOSPITAL IN NORTH KONA.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
NEW HOSPITAL	very important	75%	86%	70%	76%	71%	81%	71%	75%	64%	78%	76%	72%	75%	75%
	fairly important	9%	5%	10%	10%	8%	5%	10%	8%	11%	11%	9%	8%	10%	8%
	somewhat important	9%	4%	10%	5%	9%	4%	12%	11%	14%	5%	8%	13%	9%	8%
	not at all important	6%	4%	10%	5%	11%	8%	7%	6%	11%	6%	7%	6%	6%	9%
	DK/NA	1%	1%	0%	0%	1%	3%	0%	0%	0%	0%	0%	1%	1%	0%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1d. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE NEW HOUSING UNITS AFFORDABLE TO THE AVERAGE KONA FAMILY.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
MORE NEW AFFORDABLE HSNG	very important	66%	69%	65%	62%	58%	73%	67%	65%	63%	62%	61%	85%	67%	64%
	fairly important	14%	14%	12%	15%	15%	8%	10%	17%	11%	20%	16%	6%	13%	15%
	somewhat important	10%	6%	11%	11%	9%	6%	14%	8%	14%	11%	11%	7%	9%	10%
	not at all important	9%	9%	10%	9%	5%	9%	9%	10%	9%	6%	10%	3%	10%	8%
	DK/NA	2%	1%	2%	3%	3%	4%	0%	0%	3%	2%	2%	0%	1%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1f. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE BUSES SERVING THE NORTH KONA AREA.

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
MORE BUSES	very important	51%	62%	50%	49%	47%	63%	43%	54%	52%	32%	49%	62%	42%	56%
	fairly important	18%	14%	18%	19%	21%	15%	22%	17%	16%	26%	19%	14%	19%	18%
	somewhat important	17%	9%	16%	21%	15%	8%	10%	17%	19%	29%	17%	13%	23%	12%
	not at all important	8%	8%	9%	9%	4%	6%	9%	10%	6%	11%	6%	6%	10%	6%
	DKNA	6%	6%	6%	2%	9%	8%	10%	3%	6%	2%	6%	6%	5%	6%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1j. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE ACTIVE SPORTS PLAYING FIELDS.

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
MORE ACTIVE SPORTS FIELDS	very important	40%	48%	42%	45%	21%	48%	38%	44%	48%	29%	38%	54%	38%	42%
	fairly important	21%	18%	24%	18%	23%	20%	14%	17%	19%	31%	21%	18%	17%	24%
	somewhat important	21%	14%	19%	19%	31%	18%	14%	25%	22%	23%	22%	15%	25%	17%
	not at all important	13%	13%	12%	13%	17%	9%	26%	11%	8%	14%	14%	10%	17%	10%
	DKNA	5%	6%	3%	5%	8%	5%	9%	3%	3%	3%	6%	3%	2%	7%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1g. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
FASTER DEVELOPMENT OF HAWAIIAN HOME LANDS AREAS.

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
FASTER DEV. OF HAWN HOME LANDS	very important	36%	46%	39%	29%	25%	44%	40%	35%	33%	29%	26%	9%	33%	38%
	fairly important	17%	19%	17%	16%	13%	20%	17%	15%	14%	20%	13%	3%	18%	15%
	somewhat important	21%	10%	21%	25%	23%	11%	19%	21%	23%	28%	18%	3%	23%	19%
	not at all important	18%	14%	15%	20%	23%	15%	16%	23%	14%	18%	16%	2%	20%	16%
	DKNA	10%	6%	9%	10%	12%	9%	5%	6%	11%	5%	5%	2%	7%	12%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	82%	18%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1h. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE DOCTORS AND MEDICAL PERSONNEL.

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
MORE DOCTORS/MED. STAFF	very important	90%	91%	90%	95%	91%	91%	84%	90%	88%	95%	91%	90%	87%	93%
	fairly important	5%	5%	6%	5%	3%	3%	7%	6%	6%	3%	5%	4%	5%	5%
	somewhat important	2%	1%	2%	3%	1%	0%	5%	3%	5%	2%	2%	3%	4%	1%
	not at all important	2%	1%	2%	2%	1%	5%	2%	1%	0%	0%	2%	1%	2%	1%
	DKNA	1%	1%	0%	0%	4%	1%	2%	0%	2%	0%	1%	1%	2%	0%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q2. Have you read or heard that the County just approved a new Kona Community Development Plan?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
HEARD THAT COUNTY APPROVED NEW KONA COMM. DEV. PLAN	yes	28%	12%	29%	29%	40%	14%	31%	30%	34%	38%	30%	20%	29%	27%
	no	71%	87%	71%	68%	59%	85%	67%	69%	66%	60%	68%	80%	70%	71%
	DKNA	2%	1%	1%	3%	1%	1%	2%	1%	0%	2%	2%	0%	1%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q3. From what you have read or heard, what do you think are the best parts of this new plan?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
Q3: Best Parts of this Plan	DK/Need more info	41%	67%	46%	40%	30%	36%	39%	38%	41%	43%	41%	50%	43%	37%
	more roads / traffic alleviation	14%	11%	14%	11%	17%	18%	11%	10%	16%	16%	15%	0%	15%	13%
	good plan/like the plan	13%	22%	11%	11%	13%	18%	22%	10%	14%	4%	10%	29%	6%	17%
	puts everything in one area	7%	0%	8%	6%	10%	9%	0%	14%	5%	8%	9%	0%	4%	10%
	other	7%	11%	6%	9%	3%	18%	0%	10%	5%	6%	6%	7%	6%	6%
	more recreational facilities	6%	0%	11%	3%	7%	9%	11%	5%	14%	0%	6%	0%	6%	11%
	hospital is needed	5%	0%	5%	6%	7%	9%	11%	5%	9%	0%	5%	7%	4%	6%
	good location	5%	0%	0%	6%	10%	0%	6%	0%	9%	4%	5%	0%	6%	3%
	preservation of land	5%	0%	5%	0%	10%	0%	17%	5%	0%	0%	4%	0%	2%	6%
	more affordable hsng	3%	0%	0%	6%	3%	0%	11%	0%	5%	0%	2%	7%	2%	3%
	UH will be there	3%	0%	3%	3%	3%	0%	6%	5%	0%	4%	3%	0%	6%	0%
	Infrastructure included in plan	3%	0%	3%	3%	3%	0%	0%	0%	9%	4%	3%	0%	0%	5%
	community input	3%	0%	0%	3%	7%	0%	0%	5%	0%	8%	2%	7%	6%	0%
	considers cultural values	2%	0%	3%	3%	0%	0%	0%	0%	5%	0%	2%	0%	0%	3%
	dev. thoughtfully considered	1%	0%	3%	0%	0%	0%	0%	0%	5%	0%	1%	0%	0%	2%
	don't like new developments	1%	0%	0%	3%	0%	0%	0%	5%	0%	0%	1%	0%	2%	0%
	creates new jobs	1%	0%	0%	3%	0%	0%	0%	0%	0%	0%	1%	0%	0%	2%
BASE		111	9	37	35	30	11	18	21	22	25	93	14	48	63

FAQ Hawaii, Inc. (2009)

Q1k. First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
MORE ELEMENTARY AND INTERMEDIATE SCHOOLS.

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
MORE ELE. & MIDDLE SCHOOLS	very important	34%	48%	32%	32%	27%	43%	26%	35%	33%	35%	32%	44%	31%	36%
	fairly important	18%	16%	14%	23%	19%	19%	14%	14%	22%	18%	19%	13%	21%	15%
	somewhat important	17%	10%	20%	13%	24%	10%	17%	21%	17%	17%	17%	17%	16%	18%
	not at all important	15%	14%	15%	16%	15%	10%	22%	15%	13%	17%	16%	6%	17%	14%
	DKNA	17%	12%	19%	17%	16%	18%	21%	11%	16%	12%	17%	18%	15%	18%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q1L First, I'm going to read a list of possible needs for North Kona. For each one, please tell me if you think it is a very important need, fairly important, somewhat important, or not important at all.
DEVELOPING A MID-LEVEL ROAD MAUKA OR QUEEN KA'AHUMANU HIGHWAY AND MAKAI OF MAMALAHOA HIGHWAY, IN BETWEEN AND PARALLEL TO BOTH OF THEM.

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
DEVELOPING MID-LEVEL ROAD	very important	56%	61%	55%	57%	51%	53%	47%	65%	62%	57%	59%	45%	55%	57%
	fairly important	14%	14%	13%	16%	11%	20%	12%	14%	17%	8%	13%	18%	16%	12%
	somewhat important	13%	12%	14%	11%	17%	10%	17%	10%	16%	15%	12%	17%	11%	15%
	not at all important	14%	10%	16%	13%	15%	14%	21%	10%	13%	18%	13%	14%	14%	14%
	DKNA	3%	3%	2%	3%	7%	3%	3%	1%	3%	2%	3%	6%	4%	3%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q5a. Did you personally go to any meetings or have any input to this plan?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
PERSONALLY GO TO MEETINGS ABOUT PLAN	yes	31%	11%	27%	23%	50%	18%	33%	24%	32%	24%	32%	21%	29%	32%
	no	69%	89%	73%	77%	50%	82%	67%	76%	68%	76%	68%	79%	71%	68%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		111	9	37	35	30	11	18	21	22	25	93	14	48	63

FAQ Hawaii, Inc. (2009)

Q6a. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
PLANNING FOR KONA IS MOSTLY ABOUT WHERE AND HOW GROWTH HAPPENS, NOT TRYING TO MAKE GROWTH HAPPEN FASTER OR SLOWER.

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
PLANNING FOR KONA IS MOSTLY WHERE/HOW GROWTH HAPPENS	strongly agree	50%	40%	47%	56%	55%	43%	50%	64%	48%	55%	52%	45%	51%	49%
	somewhat agree	34%	32%	40%	29%	31%	35%	34%	35%	38%	34%	34%	30%	34%	33%
	somewhat disagree	7%	14%	5%	5%	5%	10%	9%	6%	6%	5%	4%	17%	6%	6%
	strongly disagree	4%	3%	5%	3%	3%	3%	5%	3%	2%	2%	4%	1%	1%	5%
	DK/NA	6%	10%	3%	6%	7%	9%	2%	3%	6%	5%	6%	7%	5%	6%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		403	77	129	119	78	79	58	71	64	65	314	71	169	234

FAQ Hawaii, Inc. (2009)

Q4. From what you have read or heard, what are the worst parts of the plan, or what worries you about it?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
Q4: Worst Parts of this Plan	DK/Need more info	46%	78%	43%	46%	40%	45%	56%	43%	41%	52%	45%	50%	46%	44%
	No answer	11%	11%	14%	11%	7%	16%	11%	10%	14%	12%	12%	7%	13%	10%
	no action will be taken	10%	0%	3%	9%	23%	0%	6%	14%	6%	12%	9%	21%	6%	13%
	other	9%	0%	5%	14%	10%	9%	11%	19%	0%	4%	10%	0%	8%	11%
	too much development	5%	0%	5%	6%	3%	9%	6%	5%	5%	0%	5%	0%	6%	2%
	poor road plans	5%	11%	8%	3%	0%	9%	0%	5%	5%	4%	3%	7%	4%	5%
	high cost of development	5%	0%	5%	6%	3%	9%	0%	0%	9%	0%	5%	0%	4%	5%
	will take too long to complete	4%	0%	3%	3%	7%	0%	0%	0%	5%	8%	4%	0%	4%	3%
	not enough emphasis on schools	4%	0%	5%	6%	0%	0%	0%	0%	14%	0%	4%	0%	0%	6%
	not enough community input	4%	0%	11%	0%	0%	0%	0%	0%	5%	8%	4%	0%	2%	5%
	increase traffic	4%	11%	3%	3%	3%	9%	6%	5%	0%	0%	2%	7%	4%	3%
	not a long-term solution	2%	0%	0%	3%	3%	0%	6%	0%	5%	0%	1%	7%	0%	3%
BASE		111	9	37	35	30	11	18	21	22	25	93	14	48	63

FAQ Hawaii, Inc. (2009)

Q5. Do you believe this plan was based on what you would call a great deal of community input, a moderate amount of community input, or very little community input?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
AMOUNT OF COMMUNITY INPUT ON PLAN	great deal of community input	25%	22%	14%	26%	40%	18%	6%	29%	32%	32%	27%	14%	21%	29%
	moderate amount of community input	37%	22%	33%	43%	33%	45%	50%	38%	27%	36%	40%	21%	40%	35%
	very little community input	23%	33%	22%	29%	13%	18%	17%	19%	27%	24%	20%	29%	25%	21%
	other	1%	0%	3%	0%	0%	9%	0%	0%	0%	0%	1%	0%	2%	0%
	DK/NA	14%	22%	24%	3%	13%	9%	28%	14%	14%	8%	12%	36%	13%	16%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		111	9	37	35	30	11	18	21	22	25	93	14	48	63

FAQ Hawaii, Inc. (2009)

Q6d. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
GROWTH NORTH OF KONA SHOULD BE DIRECTED MOSTLY INTO COMPACT MIXED-USE VILLAGES, WITH OPEN SPACE IN BETWEEN THEM.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
GROWTH N. OF KONA SHOULD BE INTO COMPACT MIXED-USE	strongly agree	43%	36%	44%	39%	56%	38%	48%	39%	45%	62%	45%	37%	41%	44%
	somewhat agree	32%	29%	32%	39%	27%	34%	31%	32%	39%	29%	31%	42%	32%	32%
	somewhat disagree	11%	17%	12%	6%	6%	11%	9%	13%	11%	6%	10%	13%	14%	9%
	strongly disagree	7%	6%	6%	6%	7%	6%	9%	10%	0%	9%	6%	6%	8%	6%
	DKNA	7%	10%	6%	6%	3%	10%	3%	6%	5%	3%	8%	3%	5%	9%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q6e. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
THE NEW VILLAGES SHOULD BE CENTERED AROUND BUS TRANSIT STOPS ON THE NEW MID-LEVEL ROAD.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
NEW VILLAGES SHOULD BE CENTERED AROUND TRANSIT STOPS	strongly agree	44%	42%	47%	39%	49%	47%	36%	44%	47%	46%	45%	45%	37%	49%
	somewhat agree	36%	33%	30%	41%	35%	37%	48%	31%	41%	29%	35%	37%	42%	32%
	somewhat disagree	6%	3%	6%	8%	3%	0%	7%	7%	6%	9%	7%	3%	7%	5%
	strongly disagree	9%	9%	9%	7%	11%	6%	7%	11%	5%	11%	8%	10%	11%	7%
	DKNA	6%	9%	5%	6%	3%	10%	2%	7%	2%	5%	6%	6%	4%	7%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q6b. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
MOST FUTURE GROWTH SHOULD BE LOCATED NORTH OF KAILUA, TOWARD THE AIRPORT.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
MOST FUTURE GROWTH SHOULD BE NORTH OF KAILUA	strongly agree	37%	38%	35%	34%	43%	29%	33%	37%	43%	38%	37%	35%	40%	34%
	somewhat agree	34%	35%	33%	36%	31%	41%	31%	35%	27%	38%	33%	42%	31%	36%
	somewhat disagree	13%	12%	14%	15%	11%	14%	17%	14%	11%	11%	14%	13%	14%	13%
	strongly disagree	12%	9%	13%	11%	12%	11%	12%	10%	13%	11%	12%	6%	13%	11%
	DKNA	5%	6%	5%	4%	4%	5%	7%	1%	2%	2%	4%	4%	2%	7%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q6c. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
THE NEW MID-LEVEL ROAD SHOULD BE DEVELOPED AS THE MAIN ROUTE FOR BUSES OR OTHER FUTURE MASS TRANSIT CONNECTING KAILUA TO THE AIRPORT.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
MID-LEVEL ROAD SHOULD BE MAIN KAILUA-AIRPORT BUS TRANSIT ROUTE	strongly agree	39%	49%	36%	33%	35%	45%	40%	37%	38%	40%	40%	37%	33%	39%
	somewhat agree	30%	25%	29%	33%	33%	25%	29%	32%	41%	25%	28%	33%	30%	30%
	somewhat disagree	13%	14%	16%	9%	13%	16%	16%	14%	8%	12%	13%	10%	16%	11%
	strongly disagree	12%	6%	14%	12%	12%	4%	16%	14%	8%	14%	12%	7%	11%	12%
	DKNA	7%	5%	5%	8%	7%	9%	0%	3%	6%	9%	7%	7%	8%	7%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q6h. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
TO ENCOURAGE A PRIVATE LANDOWNER TO ATTRACT A NEW HOSPITAL SITE, HIGHER DENSITIES SHOULD BE ALLOWED IN THAT VILLAGE.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
HIGHER DENSITIES TO ATTRACT NEW HOSPITAL/LANDOWNER	strongly agree	34%	40%	29%	32%	37%	32%	24%	35%	27%	45%	35%	31%	38%	31%
	somewhat agree	35%	27%	35%	41%	32%	39%	43%	34%	36%	32%	35%	34%	31%	38%
	somewhat disagree	11%	13%	16%	7%	5%	8%	5%	8%	23%	9%	11%	10%	13%	9%
	strongly disagree	12%	5%	14%	10%	20%	9%	19%	17%	9%	9%	11%	14%	15%	10%
	DKNA	9%	14%	6%	10%	5%	13%	9%	6%	5%	5%	8%	11%	4%	12%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q7. Have you heard that a new development is being proposed for the Kaloko Makai area, north end mauka of Costco along Hina Lani street?

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
HEARD OF NEW DEVELOPMENT IN KALOKO MAKAI AREA	yes	56%	57%	50%	61%	56%	49%	45%	63%	66%	65%	58%	44%	62%	52%
	no	43%	42%	47%	38%	43%	47%	55%	34%	34%	34%	40%	54%	37%	47%
	DKNA	2%	1%	2%	1%	1%	4%	0%	3%	0%	2%	1%	3%	1%	2%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q6f. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
SOME VILLAGES SHOULD PROVIDE HIGHER-DENSITY HOUSING AND COMMERCIAL TO SUPPORT MAJOR JOB AREAS LIKE THE CIVIC CENTER, NEW HOSPITAL, AND NEW UNIVERSITY.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
SOME VILLAGES SHOULD PROVIDE HIGH DENSITY HOUSING	strongly agree	56%	62%	50%	53%	64%	52%	55%	59%	53%	62%	57%	54%	54%	57%
	somewhat agree	29%	26%	34%	32%	20%	33%	24%	27%	36%	23%	27%	38%	31%	28%
	somewhat disagree	5%	1%	7%	6%	3%	3%	5%	4%	9%	5%	6%	0%	5%	5%
	strongly disagree	6%	4%	5%	6%	6%	5%	12%	6%	0%	3%	6%	1%	7%	4%
	DKNA	5%	6%	4%	3%	5%	8%	3%	4%	2%	2%	4%	7%	2%	6%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q6g. I'm going to mention certain things that are part of the new Kona Community Development Plan. For each one, please tell me if you personally strongly agree, somewhat agree, somewhat disagree, or strongly disagree that this should be Kona's plan.
THERE SHOULD BE A NEW HOSPITAL ALONG THE MID-LEVEL ROAD IN ONE OF THE VILLAGES BETWEEN KAILUA AND THE AIRPORT.

			EDUCATION LEVEL				INCOME					HOME OWNERSHIP STATUS		GENDER	
		Total	up to HS grad	some college	college grad	graduate/ prof. degree	<$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	own	rent	male	female
SHOULD BE NEW HOSPITAL AROUND MID-LEVEL ROAD	strongly agree	59%	61%	61%	55%	57%	54%	67%	56%	55%	65%	60%	51%	56%	59%
	somewhat agree	27%	29%	22%	32%	23%	34%	21%	26%	25%	25%	26%	32%	28%	26%
	somewhat disagree	6%	5%	7%	4%	5%	5%	3%	4%	11%	2%	5%	10%	5%	6%
	strongly disagree	6%	0%	7%	5%	9%	1%	2%	7%	8%	5%	5%	3%	5%	6%
	DKNA	4%	5%	2%	3%	5%	5%	7%	3%	2%	2%	4%	4%	4%	4%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q10. What is the most important reason you think this is an unacceptable development?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
Q10: Most important reason you think development is unacceptable.	too big / don't need	45%	64%	41%	43%	45%	64%	55%	43%	50%	22%	43%	23%	40%	51%
	density too high	21%	36%	12%	27%	17%	29%	29%	17%	13%	21%	19%	31%	22%	19%
	too much traffic	12%	21%	15%	7%	6%	14%	6%	13%	0%	29%	13%	8%	7%	16%
	not enough infrastructure	12%	7%	15%	17%	4%	7%	0%	13%	13%	0%	11%	23%	16%	9%
	other	11%	7%	6%	17%	13%	7%	12%	4%	13%	29%	13%	0%	18%	5%
	poor location	8%	0%	6%	10%	13%	7%	0%	22%	13%	0%	7%	8%	7%	9%
	finish other projects first	7%	14%	9%	7%	0%	0%	12%	9%	19%	0%	7%	8%	9%	5%
	need to preserve land	7%	7%	9%	3%	8%	7%	12%	9%	0%	14%	5%	15%	9%	5%
	poor plan	6%	7%	9%	7%	0%	7%	6%	9%	0%	14%	5%	15%	11%	2%
	too long to complete	5%	0%	9%	3%	4%	0%	6%	0%	13%	7%	5%	8%	4%	5%
	not enough water	5%	14%	3%	3%	4%	7%	0%	4%	0%	7%	5%	8%	4%	5%
	not enough schools	4%	0%	9%	3%	0%	0%	6%	4%	13%	0%	5%	0%	2%	5%
	DK/Need more info	1%	0%	0%	0%	4%	0%	0%	0%	6%	0%	1%	0%	0%	2%
REDUCED BASE		102	14	34	30	24	14	17	23	16	14	85	13	45	57

FAQ Hawaii, Inc. (2009)

Q8. Here's a summary of the proposal, to be developed over 30 years: 5,000 housing units of various types spread over 1,150 acres, one intermediate and two elementry schools, mauka and makai commercial areas, 150-acre dryland forest preserve, and a new regional hospital on the Mid-Level Road. Does this overall package sound like a very acceptable, somewhat acceptable, somewhat unacceptable, or very unacceptable idea?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
PACKAGE SOUND GOOD?	very acceptable	27%	35%	22%	25%	29%	25%	21%	31%	23%	45%	26%	32%	30%	25%
	somewhat acceptable	44%	38%	43%	48%	36%	43%	43%	35%	50%	34%	43%	46%	41%	46%
	somewhat unacceptable	11%	6%	9%	11%	17%	4%	14%	21%	6%	6%	11%	6%	13%	9%
	very unacceptable	15%	10%	16%	14%	15%	14%	16%	11%	17%	15%	16%	10%	14%	15%
	DK/NA	3%	6%	2%	2%	3%	6%	2%	1%	2%	0%	4%	3%	2%	4%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BASE		400	77	129	119	75	79	58	71	64	65	314	71	166	234

FAQ Hawaii, Inc. (2009)

Q9. What is the most important reason you think this is an acceptable development?

		Total	EDUCATION LEVEL: up to HS grad	some college	college grad	graduate/ prof. degree	INCOME: <$35k	$35k <$50k	$50k <$75k	$75k <$100k	$100k+	HOME OWNERSHIP STATUS: own	rent	GENDER: male	female
Q9: Most important reason you think development is acceptable.	hospital is needed	36%	44%	41%	29%	31%	34%	40%	36%	43%	37%	34%	41%	39%	34%
	good plan/ meets future needs	26%	21%	24%	30%	27%	31%	25%	17%	23%	25%	26%	27%	27%	25%
	more housing / affordable housing	16%	21%	10%	16%	20%	10%	28%	21%	17%	8%	15%	18%	11%	19%
	more schools	15%	14%	18%	14%	14%	15%	15%	23%	19%	12%	13%	21%	13%	17%
	alleviate traffic	11%	7%	12%	11%	14%	14%	8%	13%	9%	10%	13%	7%	12%	11%
	increase in jobs	8%	12%	12%	6%	2%	7%	13%	13%	9%	6%	7%	11%	11%	7%
	other	8%	12%	4%	7%	10%	12%	10%	6%	4%	4%	9%	4%	8%	8%
	everything is close proximity	7%	7%	6%	7%	8%	7%	13%	9%	2%	6%	7%	6%	3%	10%
	good location	7%	2%	11%	2%	12%	7%	3%	6%	9%	12%	7%	6%	7%	7%
	long-term plan	4%	0%	4%	3%	6%	0%	5%	4%	4%	8%	5%	0%	5%	2%
	infrastructure for growing pop.	4%	2%	1%	7%	4%	7%	0%	4%	2%	4%	3%	4%	3%	4%
	good use of unused land	4%	0%	5%	3%	4%	0%	3%	4%	6%	4%	4%	2%	4%	3%
	preservation of land considered	2%	0%	2%	6%	0%	7%	3%	0%	2%	0%	2%	4%	3%	2%
	DK/Need more info	2%	2%	2%	2%	0%	2%	5%	0%	0%	0%	1%	4%	0%	3%
BASE		285	57	92	87	49	59	40	47	47	51	218	68	118	167

FAQ Hawaii, Inc. (2009)

Appendix R

Preliminary Engineering Report for Kaloko Makai
Wilson Okamoto Corporation
July 2011

DRAFT
Preliminary Engineering Report

Kaloko Makai

Kaloko, North Kona, Hawaii
TMK: 7-3-009: 17, 19, 25, 26, 28, 62 and 63

Prepared For:

SCD-TSA Kaloko Makai, LLC
1100 Alakea Street, 27th Floor
Honolulu, Hawaii 96813

Prepared By:

Wilson Okamoto Corporation
Engineers and Planners
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826
WOC Job No. 7469-04

July 2011

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APPENDICES

Appendix A Projected Wastewater Demand Calculations

Appendix B Projected Water Demand and Storage Calculations

Appendix C Kaloko Makai Development – Conceptual Wastewater Management System, Brown and Caldwell

EXECUTIVE SUMMARY

A preliminary engineering assessment for the proposed Kaloko Makai development was conducted to: (1) review the site infrastructure and utility systems, (2) determine project demands, (3) identify possible constraints, and (4) conceptualize proposed improvements to sanitary sewer, potable water, storm drainage, parking, roadway, electrical, telephone, cable, and data communications systems to support the development.

Sanitary Sewer System: An average wastewater flow of 2.2 million gallons per day and a design peak wastewater flow of 12.2 million gallons per day are projected for the development. Since the Kaloko Makai property is undeveloped, a wastewater collection system has not been installed to service the project site. Proposed improvements include an on-site treatment plant. The plant would treat effluent to be reused as irrigation water. An irrigation storage and distribution system will service parks and open space landscaping within the development.

Potable Water System: An average daily potable water demand of 3.2 million gallons per day and a maximum daily storage volume of 4.8 million gallons are projected for the development. Water service in the North Kona area is not available to support new developments. Proposed improvements include a new groundwater source, well development, desalination, and transmission and distribution system.

Site Grading, Flooding, and Storm Drainage System: Existing topography within the project is characterized by moderate mauka to makai slopes. Site elevations range from 80 feet above Mean Sea Level to 700 feet above Mean Sea Level. Drainage can be accommodated through underground drainlines and catch basins, connected to drywells and/or detention basins. Best Management Practices will be developed and implemented in coordination with the regulatory agencies.

Parking and Roadway System: The primary access to the project site is proposed along Hina Lani Street via Queen Kaahumanu Highway and the new Ane Keohoakalole Highway. Street parking will be allowed in residential areas, and parking lots will be developed for commercial areas.

Electrical, Telephone, Cable, and Data Systems: Electrical, telephone, cable TV service, and data line access to the Internet for the project will be provided through Hawaii Electric and Light Company, Hawaiian Telcom and Time Warner Cable.

1. INTRODUCTION

Based on the Conceptual Land Use Plan prepared by SCD-TSA Kaloko Makai, LLC, this Preliminary Engineering report presents the conceptual preliminary engineering assessment of the project's infrastructure and utility systems. The objective of the report is to review existing infrastructure systems, determine project demands, identify possible constraints based on the projected demands, and describe conceptual improvements relative to sanitary sewer, irrigation, potable water, storm drainage, parking, roadway, electrical, telephone, cable, and data communication systems. The proposed improvements are subject to change based on refinement of plans and availability of more detailed information. This report is a general summary of the engineering aspects of the Kaloko Makai project.

SCD-TSA Kaloko Makai, LLC, intends to develop a 1,100-acre property located within the Kaloko-Honokohau area of North Kona, Island of Hawaii. The Tax Map Keys for the project site are (3)7-3-009: 17, 25, 26, 28, and 63. (See Figure 1-1) In addition, the project continues to investigate potential for source water on Tax Map Key parcels (3)7-3-009: 19 and 62. The current conceptual land use plan identifies components of the development as follows:

Natural Zone	Natural Landscape
Sub-Urban Zone	Single Family Homes with Landscaped yards
General Urban Zone	Mix Single Family and Small Multi-Family Homes with scattered commercial use
Urban Center Zone	Shops and offices mixed with Town Homes and Large Multi-Family
Industrial Mixed Use	Light Industrial and Mixed Use
School	Elementary (2) and Middle (1) school
Hospital	West Hawaii Hospital
Judiciary/Fire Station	Judiciary Complex or Fire and Emergency Response Unit
Dryland Forest	Wildlife Preserve
Park	Recreational Parks
Open Space/Buffer	Screened Buffer Setback
WWTP	Wastewater Treatment Plant
Kohanaiki Trail	Multi-use pedestrian and bicycle path representing a historical land to sea trail.

Preservation/Buffer Area	Historic sites recommended for preservation by the project archeologist

Residential, urban, and mixed-use zones are anticipated to consist of approximately 5,000 residential units, up to 1,095,000 square feet of retail/commercial space and 42 acres dedicated for school use. Associated amenities include recreational parks and expansion of Ane Keahokalole Highway through the project.

The project site is bounded by Queen Kaahumanu Highway to the west and by the Kaloko Light Industrial Subdivision to the southwest. The project is bordered on the north, south and east by undeveloped land or other private developments in various stages of planning. The winding east-west alignment of Hina Lani Street bisects the project site. The north-south alignment of the future Ane Keohokalole Highway also bisects the project site.

KALOKO MAKAI INFRASTRUCTURE
CONCEPTUAL LAND USE PLAN

FIGURE
1-2

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*NOTE: PARCEL 28 HAS BEEN SUBDIVIDED INTO PARCEL 28 AND PARCEL 63. THE TMK MAP DOES NOT REFLECT THE CURRENT CHANGES.

OOMA 2nd-KALOKO, NORTH KONA, HAWAII.

Prepared by:
Wilson Okamoto
Corporation
Engineers • Planners

KALOKO MAKAI INFRASTRUCTURE
TAX MAP KEY: 7-3-09: 17, 25, 26, 28, AND 63

FIGURE
1-1

2. SANITARY SEWER SYSTEM

2.1 Background

The Kaloko Makai project area falls within the boundary of the County of Hawaii, Department of Environmental Management's (DEM) North Kona Sewer Master Plan. The project site is further evaluated, and excluded, under an implementation study titled North Kona Improvement District (NKID). NKID assess improvements and additions to the wastewater collection system servicing the Kealakehe Wastewater Treatment Plant (KWWTP) and its north Kona tributary area. Currently, a public and/or private wastewater collection system is not available in the Kaloko Makai project area.

2.2 Existing Conditions

Since the Kaloko Makai property is undeveloped, a wastewater collection system has not been installed to service the project site. Existing properties within the nearby Kaloko Light Industrial Subdivision are serviced by septic tank and seepage pit. Planned development within Kaloko Light Industrial Subdivision and Lanihau Properties incorporate individual septic systems for short term use and installation of dry sewers for long term build out of NKID. Current development of the Kaloko Heights project incorporates a private wastewater treatment system.

2.3 Projected Demands

Sanitary sewer volumes for the project are derived using the project's program requirements provided by SCD-TSA Kaloko Makai, LLC, and generalized simulation of projected demands for similar developments.

Based on the City and County of Honolulu, Design Standards of the Department of Wastewater Management, an average wastewater flow of 2.2 million gallons per day (MGD) is projected for the development (Big Island does not have its own wastewater standards). The projected design peak wastewater flow is approximately 12.2 MGD. (See Appendix A)

2.4 Proposed Improvements

Current DEM plan is to build a portion of NKID along with the next phase of the Queen Kaahumanu Widening project. DEM proposes to install a dry gravity force main along Queen Kaahumanu Highway from Hina Lani Street to the future pump station. Prior to becoming active, DEM needs to implement at least two more projects to connect to the KWWTP. As Kaloko Makai is not included in the NKID study, connection to, or project related upgrades, to KWWTP will not likely be allowed by DEM.

DEM is also considering development of a decentralized treatment plant. The tributary area considered for the decentralized treatment plant includes the Kaloko Makai property. The treatment plant would likely be located on state land north of Kaloko Makai and along Queen Kaahumanu Highway. Detailed planning of the decentralized treatment plan with respect to treatment system and flow capacity and footprint size has not been determined.

The current Kaloko Makai Land Use plan reserves about 20 acres for development of a private wastewater treatment plant. The plant would accept sewage effluent from the project site and treat to R-1 water. The treated water would be stored in various reservoirs on-site and distributed to parks and open buffer landscape spaces as irrigation water. Irrigation water may also be made available to commercial business or residences for use as irrigation water for landscaping.

A new County wastewater treatment plant is proposed to be located in the Kaloko Makai vicinity, and will be designed to the extent feasible to utilize a natural treatment system that can double as an open space feature.

A natural wastewater treatment plant or system is typically known as a "constructed wetland" or a "Constructed Ecosystem" and are an alternative to mechanical wastewater treatment systems, which are methods that treat and purify wastewater. Constructed wetlands simulate natural wastewater treatment systems, using flow beds to support water-loving plants. The roots of these plants help provide an aerobic environment to aggressively break down contaminants. However, concerns have been raised as to the proposed location of this new wastewater facility, especially its proximity to the Kona International Airport.

Wastewater Treatment Alternatives

If a connection to either the Kealakehe WWTP or the proposed natural wastewater treatment system is accessible to the Project prior to the County Council's approval of the Change of Zone (COZ), Kaloko Makai shall develop the Project with sewer lines to be used to connect the Project to the Kealakehe WWTP.

If the connection to the Kealakehe WWTP is not accessible to the Project prior to approval of the COZ and no connection to a public WWTP acceptable to Kaloko Makai is available, Kaloko Makai shall develop the Project to be served by a private on-site WWTP.

An on-site wastewater treatment plant will be designed to produce R-1 recycle water suitable for irrigation within the project boundaries. The treated effluent will be pumped to a R-1 storage tank located on-site and will be used to irrigate parks, school fields, landscaping and other allowed uses for R-1 recycled water. The information provided below summarizes a Kaloko Makai Development – Conceptual Wastewater Management System report prepared by Brown and Caldwell. The full report is included in Appendix C.

The WWTP will be designed to achieve the following:

a. Produce R-1 recycled water in accordance with DOH regulations; and
b. Reduce phosphorus and nitrogen concentrations in the effluent to address potential impacts to the adjacent Kaloko-Honokōhau National Historical Park and the near shore environment.

The first treatment goal is readily achievable via conventional secondary treatment, followed by coagulant addition, filtration and disinfection with ultraviolet light. The second goal requires an advanced wastewater treatment process.

Influent Pump Station: A pump station will be required to lift raw wastewater from the sewer system to the treatment processes.

Headworks: The headworks would include screening systems to remove debris and grit removal to remove inorganic particles (e.g., sand) from the waste stream. Grit and screenings will be disposed at the West Hawai'i Landfill.

Biological Treatment: Organic matter and nutrients will be removed using an activated sludge process. The process will incorporate biological nutrient removal (BNR). BNR incorporates aerobic and anoxic zones within the treatment process and recycle flows to facilitate biological reduction of TN and TP to 10 mg/L and 2 mg/L, respectively. Clarifiers will be used to separate the activated sludge from the secondary effluent.

Coagulant Addition/Flocculation: Coagulants (such as aluminum sulfate and/ or polymer) will be added to the secondary effluent downstream of the secondary clarifiers and mixed to combine small particles into larger "flocs" that can be removed in the filtration process.

Filtration: The filtration process will provide two treatment benefits: turbidity reduction to meet R-1 water recycling requirements, and additional nitrogen removal. Denitrification filters are available that are accepted by the California Department of Public Health (CD PH) for Title-22 recycled water production and are also capable of reducing TN concentrations to 5 mg/L via denitrification. The DOH allows the use of filtration processes that are accepted by CDPH for R-1 recycled water production. Addition of a carbon source (typically methanol) is required upstream of the filters to facilitate denitrification process. The DOH requires that R-I recycled water have effluent turbidity of less than 2.0 Nephelometric turbidity units (NTU) at all times.

Disinfection: The effluent will be disinfected with ultraviolent light (UV) to meet R-I recycled water requirements. The DOH requires that R-I recycled water have a median density of fecal coliform that does not exceed 2.2 per 100 mL.

Effluent Pump Station: An effluent pump station will deliver recycled water to the R-I storage tank for reuse, or to the infiltration basins for disposal.

Aerobic Digester: Waste solids (sludge) from the biological treatment and filtration systems will be pumped to an aerobic digester system for stabilization and thickening via periodic decanting.

Mechanical Dewatering: Aerobically digested sludge will be mechanically dewatered prior being hauled offsite for disposal or composting at the West Hawai'i Landfill.

Supplemental potable water will be added to the R-1 storage tank as needed to ensure that the irrigation demands of the users can be met. During periods of wet weather, excess R-1 water will be disposed of via infiltration basins.

The Kaloko Makai WWTP will be designed to reduce nitrogen and phosphorous concentrations in the treated effluent to: TN to a concentration of <5 mg/l, and TP to a concentration of <2 mg/l (aerobic nitrification processes combined with anoxic/anaerobic sand filters to perform denitrification, or comparable technology.) Installation of the Private WWTP shall be subject to conditions of approval by the DOH, including any lower concentrations of TN and/or TP in the effluent, and HAR Chapter 11-62.

During the wastewater treatment process, organic matter and nutrients will be removed using an activated sludge process. The process will incorporate biological nutrient removal (BNR). BNR incorporates aerobic and anoxic zones within the treatment process and recycle flows to facilitate biological reduction of Total Nitrogen (TN) and Total Phosphorous (TP).

The State of Hawai'i Department of Health (DOH) requires that wastewater systems be designed based on county flow standards, and if applicable county standards are not established the City and County of Honolulu standards are to be used. The County of Hawai'i (County) has not yet established wastewater flow standards. Based on City and County of Honolulu flow standards, the average dry weather flow from the development at build out is 2.4 million gallons per day (mgd).

An average R-1 recycled water flow rate of 2.37 mgd has the potential to provide irrigation water for approximately 273 acres without routine supplemental water addition. The DOH has restrictive requirements for R-1 irrigation on property located above of the Underground Injection Control (UIC) line (e.g., groundwater or vadose zone monitoring, no excess irrigation to flush salts below the root zone allowed), and therefore R-1 reuse be limited to properties located below the UIC line.

The Kaloko Makai development includes 50 acres of parks and 30 acres of schools located below the Underground Injection (UIC) Line that will likely be the largest users of the R-1 recycled water. Based on preliminary estimates, approximately 60 acres of the total park and school acreage will ultimately be irrigated. Additional recycle water users can be added to the system if they are located near the

distribution lines that carry the water to the largest users. The required R-1 water storage tank size will be based on the peak day demand of the recycled water users.

There may be times when R-1 supplies are not sufficient to meet the irrigation demands of the parcels that are connected to the R-1 distribution system. For example, in the first phase of development, there will likely be not enough R-1 water to irrigate the parks and schools that are slated for construction. Therefore, addition of supplemental water (potable and non-potable) to the R-1 storage tank will be required to ensure the irrigation demands can be met.

The proposed gravity sewer system will collect wastewater from businesses and residents located mauka of the wastewater treatment plant. A proposed gravity sewer system and lift station will collect and convey wastewater from businesses and residents located makai of the wastewater treatment plant. The sewer system design will follow DEM and City and County of Honolulu guidance and general criteria. Pipe sizes and lift station requirements will be determined during the design phase of the project.

3. POTABLE WATER SYSTEM

3.1 Background

The County of Hawaii, Department of Water Supply supplies potable water to areas in the vicinity of the project site.

3.2 Existing Conditions

The County of Hawaii Department of Water Supply (DWS) operates and maintains potable water supply facilities within the project vicinity. The DWS facilities include three water reservoirs, each with a capacity of 1.0 million gallons, and each supplying a different pressure zone. 20" transmission mains, located along Hina Lani Street, link the water reservoirs from Queen Kaahumanu Highway to Mamalahoa Highway and complete the available Hina Lani water supply system. The Hina Lani water system provides water to the Kaloko Light Industrial subdivision, as entitled, for that particular subdivision.

Of the three existing water reservoirs, the makai reservoir has been abandoned by DWS and will be dedicated to DEM for potential use as a R-1 water storage reservoir.

DWS currently has three planned construction projects within the vicinity of Kaloko Makai. DWS is participating with the Department of Transportation, Highways Division's (DOT) in the Queen Kaahumanu Highway Widening Project, Phase II to install a new 16" water main in parallel with an existing 12" water main along Queen Kaahumanu Highway. Another project is a water tank currently in construction for the Kaloko Heights project. The third project is another water tank along Hina Lani Street, which would be the last water tank developed for the Hina Lani water system. DWS does not have plans to construct any other wells, water supply tanks, transmission mains or distribution mains within the North Kona area.

3.3 Projected Demands

Potable water demand for the project site is derived using the project's program requirements provided by SCD-TSA Kaloko Makai, LLC, and generalized simulation of projected demands for similar developments.

Based on demand factors shown in the County of Hawaii, Department of Water Supply, Water System Standards, 2002, average daily potable water demand of 3.2

MGD is projected for the project site. The projected maximum daily consumption is approximately 4.8 MGD, and maximum daily consumption plus fire flow demand is approximately 5.0 MGD. The anticipated required storage volume for the entire project site is approximately 7.0 million gallons. (See Appendix B)

3.4 Proposed Improvements

Pursuant to a meeting with DWS staff, DWS indicated that due to delays with the planning and construction of the Mid-Level Road, water service in the North Kona area is not adequate to support new developments. DWS further indicated that the project should develop a new groundwater source and provide a new potable water system which includes treatment, storage, transmission and distribution facilities. In preliminary discussions with the DWS, the Hina Lani water system appears adequately designed to accept the proposed project water facilities. The new water system will be designed and dedicated to DWS and a development credit to facility charges will apply.

DWS noted that well development should be a project priority since many other private land owners in North Kona are searching for well locations. DWS also noted that presenting before the water resources commission should also be a project priority. DWS indicated that, typically, wells located above an elevation of 1,700-feet would most likely tap into a good and reliable water source.

Kaloko Makai is investigating at least six alternatives, developed with Tom Nance Water Resources and Ho'okuleana, LLC, Inc., for its potable water needs. These alternatives include:

1. Utilization of off-site wells (at top of Kaloko Heights property, approximate 1,000-ft elevation;) possible desalination to potable (preferred alternative)
2. Utilization of off-site wells (approximate 1,700-ft elevation
3. Utilization of on-site wells (at top of the property, approximate 700-750-ft elevation;) possible desalination to potable
4. Partnership with private water system owners (i.e. transfer of water commitments, subject to amendment of prior agreements and County approval)
5. Connection to the County of Hawai'i potable water system (allocation based on number of permitted units based on existing zoning)
6. Combination of the above alternatives

The off-site, 1,000 ft elevation system will be comprised of a system of potable wells within a well field located adjacent to the property within TMK Nos. (3) 7-3-009: portions of 019 and 062, at an approximate 1,000 ft elevation

In providing sources of potable water for Kaloko Makai, Kaloko Makai will comply with all laws and regulations. As necessary, Kaloko Makai will undertake additional research to assess the potential impacts and appropriate mitigation measures of the selected systems.

1 - Utilization of off-site wells (at the approximate 1,000-ft elevation; possible desalination to potable) (preferred alternative)

Under this preferred alternative, 3-4 mid-level off-site wells will be drilled at an elevation of approximately 1,000-feet within the mauka portion of the Kaloko Heights property or in the immediate vicinity. In the event potable water is not attained, then an on-site desalination facility will be constructed within the Kaloko Makai project.

These wells will be drilled to tap into freshwater that is found at depth, through the traditional basal lens, as well as through the underlying seawater below the brackish lens, to a layer of fresh water below these two layers.

- The project consists of the following elements:
  - Exploratory then Production well with a 1,000 to 1,500-gpm deep submersible pump and appurtenances
  - Pump control building
  - Fencing
  - Access road improvements
  - 1- to 2-million gallon concrete reservoir (as required by DWS)
  - Utilizations of transmission line along the access road to connect to an existing water main on Hina Lani Street

Cost of construction would be borne by Kaloko Makai. The facilities may be dedicated to the Hawai'i County Department of Water Supply (DWS) and an agreement negotiated with the DWS for use of the water.

Each mid-level well is anticipated to yield from 1.0-2.0 MGD. This amount is not significant in terms of the remaining sustainable yield of the aquifer. No adverse groundwater effects have been observed from any of the existing wells in the regions, individually or cumulatively.

On-site Desalination If Off-site Wells Proves Too Saline

While potable water is expected from these off-site mid-level wells, in the event the water does not meet DOH standards for domestic use (i.e. too saline,) then the groundwater will be desalinated in an on-site desalination facility; this is an extension of the preferred alternative for water source for the Kaloko Makai project.

The desalination plant would be situated in the vicinity of the middle water tank in Kaloko Makai and feed lines from the wells to the treatment facility would follow along Hina Lani Street. The Treatment facility would treat the water through a reverse osmosis (RO) process. Prior to RO, the feedwater from the wells is pre-treated to remove particles that can negatively affect the RO membranes and adjust the acidity of the well water. This pretreatment will reduce damage and wear to RO membranes, which increase the RO process performance and life span of the system.

After pre-treatment, water is sent through the RO membranes at high pressure this filters and reduces total dissolved solids. The pressure to force the water through the membranes would be the grade separation and gravitational force as the water runs from the well sites to the treatment facility. The water is then conditioned for pH adjustment and disinfection. The water can then be used as "potable" drinking water.

The byproduct of the RO process is a concentrated saline brine solution; it will be discharged in on-site deep disposal wells, at depths below the feedwater source and below the basal groundwater, in an area with 30 ppt salinity.

Since the concentrate has a greater density than the surrounding saline groundwater, it will flow seaward without rising above the surrounding saline groundwater and will not rise to the basal freshwater layer. It is then discharged into the ocean offshore at a substantial depth and distance from the shoreline.

The saline concentrate discharge wells will be situated below the Underground Injection Control (UIC) line.

In addition to potable water and concentrated saline brine solution, the desalination process will also produce small amounts of reject water from the pre-treatment process, water from membrane cleaning and membrane cleaning solution. These

by-products will be properly treated and processed at the on-site wastewater treatment facility or disposed of in the same deep wells used for the concentrated brine solution.

The on-site desalination facility will include storage, transmission and distribution system proposed for Kaloko Makai. Due to the grade separation of the Kaloko Makai site, the gravity fed desalination facility will be located within Kaloko Makai, downhill from the feed wells. The facility will be situated near the middle existing DWS water tanks on Hina Lani Street, just below Ane Keohokālole Highway.

Once the water is treated, it will be put into the existing DWS water system. DWS will then service Kaloko Makai, as well as other down gradient customers in the existing DWS system. DWS may require improvements to the system, including additional storage and waterlines. Space for expansion of water storage reservoirs will be set aside by Kaloko Makai for future use by DWS; improvements and additions will be implemented, as needed by DWS.

The proposed desalination system will be subject to regulation as a public water system and will meet conditions of the State Department of Health, including HAR Chapter 11-20, 11-21, and 11-25. The desalination water system will have no impact on potable or brackish groundwater. Likewise, it will not affect nearshore waters. This includes groundwater used by neighboring projects or anchialine pools and fishponds in the area, including nearby Kaloko-Honokōhau National Park.

2 - Utilization of off-site wells (approximate 1,700-ft elevation

Under this alternative, four to five higher elevation, off-site wells would be drilled at the approximate 1,700 – 2,000-foot elevation on the western flank of Hualālai volcano.

Sites would be negotiated and cost of construction would be borne by Kaloko Makai. The facility may be dedicated to the Hawai'i County Department of Water Supply (DWS) and an agreement negotiated with the DWS for use of the water.

The well would tap into the Keauhou Aquifer (Aquifer Code 80091). Based on recent well drilling experience in the region, the water table will likely be found at approximately 60 to 80 feet above sea level or about 1,700 feet below ground. Experience of wells in this vicinity indicates a production well could sustainably pump up to approximately 1,100 gallons per minute (gpm).

The project consists of the following elements

- Production well with a 1,000 - 1,500-gpm deep submersible pump and appurtenances
- Pump control building
- Fencing
- Access road improvements
- 1- to 2-million gallon concrete reservoir (as required by DWS)
- New 12- to 16-inch transmission line along the access road to connect to an existing 16-inch water main on Māmalahoa Highway

3 - Utilization of on-site wells (at top of the property, approximate 700-750-ft elevation; possible desalination to potable)

Three to four Kaloko Makai on-site mid-level wells would be drilled near the mauka portion of the project area (at the approximate 700 to 750-foot elevation.) These wells will be drilled to tap into freshwater that is found at depth. This is the preferred alternative for water source for the Kaloko Makai project.

As noted in alternative 1 above, these wells will not draw from the traditional basal lens; therefore, they will not significantly affect the brackish basal water source that flows into the coastal anchialine and other ponds.

The project consists of the following elements

- Exploratory then Production well with a 1,000 to 1,500-gpm deep submersible pump and appurtenances
- Pump control building
- Fencing
- Access road improvements
- 1- to 2-million gallon concrete reservoir (as required by DWS)
- Utilizations of transmission line along the access road to connect to an existing water main on Hina Lani Street

Cost of construction would be borne by Kaloko Makai. The facilities may be dedicated to the Hawai'i County Department of Water Supply (DWS) and an agreement negotiated with the DWS for use of the water.

Each mid-level well is anticipated to yield from 1.0-2.0 MGD. This amount is not significant in terms of the remaining sustainable yield of the aquifer. No adverse

groundwater effects have been observed from any of the existing wells in the regions, individually or cumulatively.

4 - Partnership with private water system owners (i.e. transfer of water commitments, subject to amendment of prior agreements and County approval)

Several existing and proposed projects have excess water resources (beyond their immediate needs,) either through existing water credits and/or exploratory and/or production wells. Kaloko Makai is negotiating with these parties and DWS to seek allocation of water resources for the project.

5 - Connection to the County of Hawai'i potable water system (allocation based on number of permitted units based on existing zoning)

While there are no significant water commitments for the Kaloko Makai project, Kaloko Makai will continue discussions with the Hawai'i County Department of Water Supply (DWS) for allocation of water from the existing system.

Discussions with the DWS indicates DWS typically allocates water based on existing zoning. Following is a summary of the parcels and their existing zoning:

(3) 7-3-009:017 – 224.430 acres Conservation
(3) 7-3-009:025 – 360.131 acres 170 acres - A-5a; 190 acres - golf course
(3) 7-3-009:026 – 194.324 acres A-5a;
(3) 7-3-009:028 – 313.112 acres 150 acres - dryland forest; 163 acres - A-5a
(3) 7-3-009:063 – 46.869 acres A-5a

Addressing only the properties zoned Ag 5-ac, based on their land area, there are approximately 145 units permitted under the existing zoning, however, the DWS must confirm this preliminary determination.

6 - Combination of the above alternatives

A combination of the above alternatives is also considered. This may include a variety of combinations and scales of water sources noted above. No additional environmental or ecological impacts are expected from use of any combination of the alternatives.

Water source and storage for the project should be located, tested and developed during the preliminary planning stages. Desalination plant, reservoir locations, pressure zones, booster pumps and on-site and off-site transmission system will be determined during the design phase. The on-site potable water distribution system will be determined during the design phase of the project, one the final location of the project roadways is approved by the County Department of Public Works.

The fire protection system will consist of an appropriate meter and waterline extension to the various parts of the project site. The need of additional pressurized system for the proposed project will be determined by the Mechanical or other consultants during the design phase of the project. The Fire Department will be consulted during the design phase of the project to determine the need for on-site fire hydrants and to review fire truck access requirements.

4. SITE GRADING, FLOODING, AND STORM DRAINAGE SYSTEM

4.1 Background

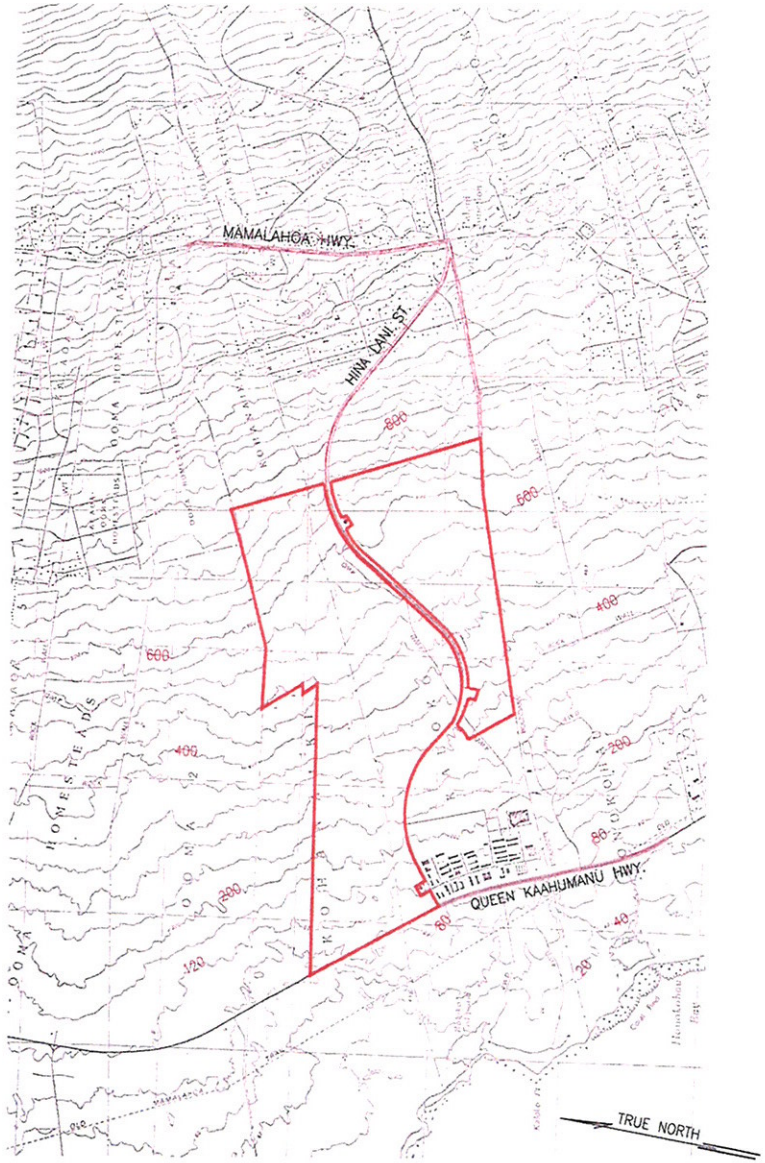
The review of the site grading, flooding, and storm drainage system is based on current regulations of the County of Hawaii Department of Public Works, the applicable State of Hawaii and federal regulations, and the United States Geological Survey (USGS) Quadrangle Maps "Keahole Point, HI (1996)" and "Kailua, HI (1996)".

4.2 Existing Conditions

The proposed project area is located along the west coast of the Island of Hawaii, mauka of Queen Kaahumanu Highway. Based on information shown on the USGS maps, existing topography is characterized by moderate mauka to makai slopes. Site elevations range from 80 feet above Mean Sea Level along Queen Kaahumanu Highway to 700 feet above Mean Sea Level along the mauka boundary. (See Figure 4-1) Based on the topographic survey map provided, there are no definable natural storm drainage flow patterns within the project site or any pattern showing offsite flows entering the project site. There are also no existing storm drainage systems in the vicinity of the project site.

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), Community Panel 155166 0692C revised April 02, 2004, shows that the project site is within Zone "X", defined by the FIRM map as "Areas determined outside of 500-year flood plain." The other FIRM panel covering the project, Panel 155166 0684C, is defined as "Panel Not Printed". All unprinted panels are determined to be in Zone X. (See Figure 4-2)

The County of Hawaii currently operates and maintains a series of swales and drywells along Hina Lani Street. Typically, the V-type swales are 6' wide running along roadside shoulders. Drywells are located to intercept runoff collected in the swales and are approximately 5-feet in diameter, 20-feet deep, and capped with a catch basin/grated inlet drywell cover. Drywells allow collected storm water runoff to percolate into the ground to replenish ground water source.



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Engineers • Planners

KALOKO MAKAI INFRASTRUCTURE
TOPOGRAPHIC MAP

FIGURE 4-1

4.3 Proposed Improvements

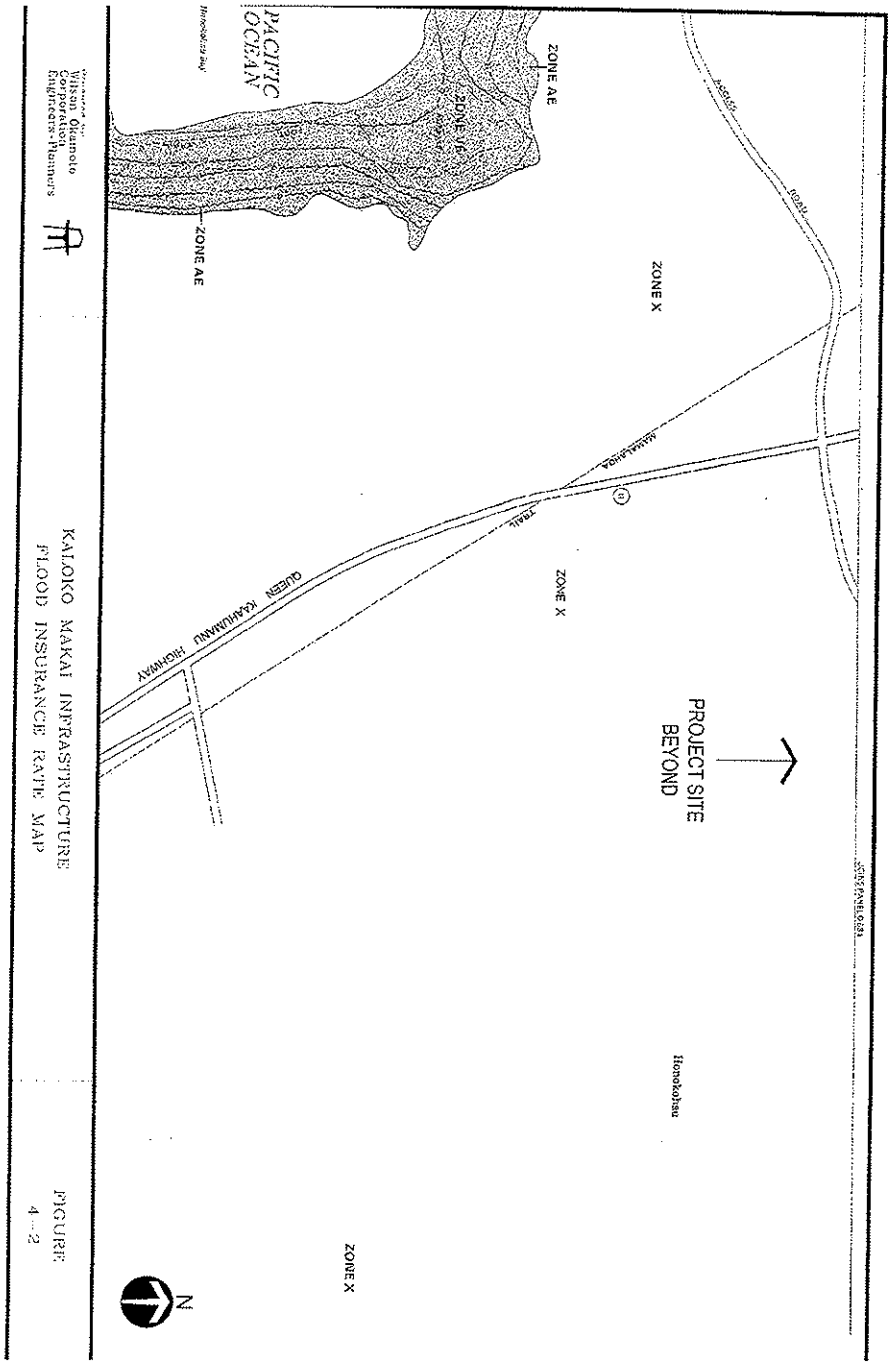
Since there currently is no existing storm drainage system in the vicinity of the project site to dispose of surface flows, all increases in storm runoff volumes for a 10-year 1-hour storm resulting from the development, will be required to be retained on-site.

The on-site drainage system will likely consist of drywells and/or detention basins located at low spots at various locations throughout the project site. Depending on the type of development proposed, use of an underground storm drainage system consisting of drainlines, drain inlets, and storm drain manholes may be required to collect and convey storm drainage runoff to the drywells and/or detention basins. The actual number of drywells and size of detention basins will be determined during the design phase of the project. A geotechnical engineer should be retained during the construction phase of the project to verify percolation results of the drywells to confirm discharge capacities. Should deep drywells be required, an Underground Injection Well Permit will need to be obtained.

Storm drainage volumes for the project, including determination of line sizes, inlet locations, drywell requirements and detention/retention requirements will be determined during the design phase of the project.

Permanent Best Management Practices (BMP) will be implemented to filter pollutants from storm water runoff and limit the amount of pollutants entering the ground water. Permanent BMPs will be determined during the design phase of the project and may include: swales, infiltration trenches, bioretention, retention basins, underground retention pipes, mechanical filter inlets, and/or hydrodynamic manholes.

Percolation of Irrigation/External Water Uses – Sources of irrigation water for Kaloko Makai will come from recovered R-1 treated wastewater and from the potable system. It is assumed that approximately 15% of applied irrigation water will percolate down to the basal ground water. As the excess irrigation water percolates downward through the unsaturated zone to the groundwater, removal rates of nitrogen and phosphorus from the water will be significant.



Storm and Surface Water Runoff – Potential water quality impacts during construction of the project will be mitigated by adherence to State and County water quality regulations governing grading, excavation and stockpiling. The County's grading ordinance includes provisions related to reducing and minimizing the discharge of pollutants associated with soil disturbing activities in grading, grubbing and stockpiling.

BMPs will be utilized in compliance with County ordinances pertaining to grading, grubbing, stockpiling, soil erosion and sedimentation during construction. BMPs will also be implemented for long term development and operation of activities occurring on the site as part of pollution prevention measures.

The project's proposed drainage system will be designed to minimize impacts to near shore coastal waters. Water quality treatment and detention basins will be built to prevent runoff and sedimentation from impacting groundwater resources. Innovative and more natural ways to handle drainage improvements will be sought to comply with the County drainage standards.

Pollution Prevention Plan (PPP) - Kaloko Makai shall develop a pollution prevention plan (PPP) that provides Best Management Practices (BMPs), including structural BMPs, for pollution prevention that address all categories of permitted uses within the Project, and shall address environmental stewardship and the non-point sources of water pollution that can be generated from any uses allowed within the Project. Emphasis shall be given to BMPs that prevent or limit pollutants arising out of the permitted uses within the Project from reaching the groundwater and ocean.

Control of contaminated surface water can be achieved through the development of a PPP designed to address all pollutants associated with the development and to identify measures that will contain and treat such pollutants in order to prevent any release into the environment, including the groundwater. There will be no anticipated adverse impact on groundwater quality from the development of this project.

5. PARKING AND ROADWAY SYSTEM

5.1 Background

The review of the parking and roadway system is based on the review of the Conceptual Land Use Plan prepared by SCD-TSA Kaloko Makai, LLC. This section will concentrate on on-site related parking and roadway system issues.

5.2 Existing Conditions

Access to the project site is provided by Queen Kaahumanu Highway and Hina Lani Street. State-owned Queen Kaahumanu Highway, located along the western boundary of the project site, is a two-way, two-lane roadway with median, currently being widened to a 4-lane divided arterial road. Hina Lani Street, a two-way, two-lane asphaltic concrete paved road section with paved shoulders and no curb, gutter, or sidewalk, bisects the project site in an east-west alignment, and connects to Queen Kaahumanu Highway at the western boundary of the project site.

5.3 Projected Demands

On-site parking requirements for the project will be based on information provided by SCD-TSA Kaloko Makai, LLC. The current site plan allows street parking in residential areas and parking lots in commercial areas.

5.4 Proposed Improvements

The primary access to the project site will be provided by Queen Kaahumanu Highway and Hina Lani Street. The Ane Keahokalole Highway (Mid-Level road) will also provide access to the project site.

Based on the Conceptual Land Use Plan prepared by SCD-TSA Kaloko Makai, LLC, the internal roadway system for the proposed project will include extending Kamau Street. The Ane Keohokalole Highway (Mid-Level Road), is a secondary arterial being developed by the County of Hawaii bisecting the project site in a south-north alignment and will be developed as part of the project road improvements.

6. ELECTRICAL, TELEPHONE, CABLE, AND DATA SYSTEMS

6.1 Background

Electrical, telephone, data line access to the Internet, and cable TV service for the project will be provided by Hawaii Electric and Light Company (HELCO), Hawaiian Telcom and Time Warner Cable.

6.2 Existing Conditions

The existing electrical, telephone, and cable systems in the vicinity of the project site consists of overhead lines located along Queen Kaahumanu Highway.

6.3 Projected Demands

The project will need to contact HELCO to confirm the availability of service in the area as well as identify any other constraints or items that may be of concern.

6.4 Proposed Improvements

Electrical, telephone, cable TV service, and data line access to the Internet for the project, if available, will be provided through Hawaii Electric and Light Company, Hawaiian Telcom and Time Warner Cable.

7. OTHER UTILITIES

7.1 Fuel Systems

If propane or diesel fuel service is required, an on-site tank system would be required since no gas or fuel lines exist near the project site. Sizing and locations of the various fuel tanks will be determined during the design phase of the project.

APPENDICES

Kaloko Makai Wastewater Demands

Average Wastewater Flow:

Phase 1	Capita	gpd/Capita	gpd
Residential	5364	80	429,120
Commercial	3430	40	137,200
Light Industrial	7520	80	601,600
Elem School	750	25	18,750
Park	1388	20	27,760
Total Phase 1			1,214,430
Phase 2	**Capita**	**gpd/Capita**	**gpd**
Residential	5498	80	439,840
Commercial	1182	40	47,280
Hospital	150	400	60,000
Middle School	1000	25	25,000
Lodge	480	80	38,400
Park	524	20	10,480
Total Phase 2			621,000
Phase 3	**Capita**	**gpd/Capita**	**gpd**
Residential	4120	80	329,600
Commercial	319	40	12,760
Elem School	750	25	18,750
Police Substation	20	80	1,600
Park	400	20	8,000
Total Phase 3			370,710

Project Total (Average Wastewater Flow)	**2,206,140**
Design Peak Flow (gpd)	12,230,733
Dry Weather Infiltration/Inflow @ 5 gpdc	**164,475**
Design Average Flow (Avg Flow + Dry Weather)	**2,370,615**

Revised: 7/25/2011

Kaloko Makai Water Demands

Average Daily Use:

Phase 1	**Units/SqFt/Acres**	**gpd/Scale**	**Scale**	**gpd**
Residential	1,819	400	/unit	727,600
Commercial	630,000	130	/1000 SF	81,900
Light Industrial	75	4,000	/acre	300,000
Judiciary	10	3,000	/acre	30,000
School	12	4,000	/acre	48,000
Parks	34.7	5,000	/acre	173,500
Total Phase 1				1,361,000
Phase 2	**Units/SqFt/Acres**	**gpd/Scale**	**Scale**	**gpd**
Residential	1,946	400	/unit	778,400
Commercial	370,000	130	/1000 SF	48,100
Hospital	40	4,000	/acre	160,000
Lodge	120	400	/unit	48,000
School	18	4,000	/acre	72,000
Parks	13.1	6,000	/acre	78,600
Total Phase 2				1,185,100
Phase 3	**Units/SqFt/Acres**	**gpd/Scale**	**Scale**	**gpd**
Residential	1,235	400	/unit	494,000
Commercial	100,000	130	/1000 SF	13,000
School	12	4,000	/acre	48,000
Police Substation	3	3,000	/acre	9,000
Parks	11.2	6,000	/acre	67,200
Total Phase 3				631,200
Project Total (Average Demand)				**3,177,300**
Max Day Demand (gpd) (Average Demand x 1.5)				4,765,950
Peak Hour Demand (gpd) (Average Demand x 5)				15,886,500

Note: the "Phase" estimates are based on "Average" daily use; there is a factor applied under "Project Total"

*** Assumptions:**

Residential - 400 gpd per unit (all unit types: SF, MF low-rise or MF high-rise)
Commercial - 130 gpd per 1,000 SqFt
Light Industrial - 4,000 gpd per acre
Hospital - 4,000 gpd per acre
Hotel - 400 gpd per unit (or 17,000 gpd per acre)
Schools - 4,000 gpd per acre
Parks - 4,000 gpd per acre, 1,000-2,000 gpd for potable use
(TOD Greenbelts and Dryland Forest not irrigated and Parks)
(Parks, Plazas, Squares, Roadways, etc irrigated with R-1 treated wastewater)
(Park 4 will utilitze potable water)

* Hawaii County, Water System Standards, Domestic Consumption Guidelines (Hawaii County WUDP)

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Brown AND Caldwell

July 25, 2011

Mr. Peter Phillips
Stanford Carr Development
1100 Alakea Street, Suite 2700
Honolulu, HI 96813

1055/137060

Subject: Kaloko Makai Development – Conceptual Wastewater Management System

Dear Mr. Phillips,

Stanford Carr Development is proposing to develop the 1040 acre Kaloko Makai project (project) north of Kailua-Kona on the Big Island. The land uses will include residential, retail, commercial, office, light industrial, a hospital, schools, parks, and open space. The project is located outside of the service area for the County of Hawaii's Kealakehe Wastewater Treatment Plant; therefore a wastewater management system must be developed. We have developed a wastewater management system concept for the development, based on information forwarded by Wilson Okamoto Corporation.

Estimated Wastewater Flow

The State of Hawaii Department of Health (DOH) requires that wastewater systems be designed based on county flow standards, and if applicable county standards are not established the City and County of Honolulu standards are to be used. The County of Hawaii (County) has not yet established wastewater flow standards. Based on City and County of Honolulu flow standards, the average dry weather flow from the development at buildout is 2.37 million gallons per day (mgd).

Wastewater Management System Concept

Figure 1 is a schematic diagram of the conceptual wastewater management system. Wastewater from the development would be delivered to a wastewater treatment plant (WWTP) that will be located within the project boundaries. The WWTP will be designed to produce R-1 recycled water suitable for irrigation reuse within the project boundaries. The WWTP will also be designed to reduce nitrogen and phosphorus concentrations in the treated effluent to address concerns over nutrient impacts to the adjacent Kaloko-Honokohau National Historical Park and the near shore reef environment. The treated effluent will be pumped to an R-1 storage tank and will be used to irrigate parks, school fields, streetscape, and other allowed used for R-1 recycled water. Supplemental groundwater will be added to the R-1 storage tank as needed to ensure that the irrigation demands of the users can be met at all times. Excess recycled water will be disposed via infiltration basins.

Each element of the wastewater management system is described in more detail below.

Wastewater Treatment System

The WWTP will be designed to achieve two simultaneous goals:

1. Produce R-1 recycled water in accordance with DOH regulations;
2. Reduce nutrient concentrations in the effluent to address potential impacts to the adjacent National Historical Park and near shore reef environments.

The first treatment goal is readily achievable via conventional secondary treatment, followed by coagulant addition, filtration, and disinfection with ultraviolet light. The second goal requires an advanced wastewater treatment process. The nearby Ooma project successfully negotiated with the National Park Service (NPS) to reach an agreement for effluent limits of 5 milligrams per liter (mg/L) of total nitrogen (TN) and 2 mg/L of total phosphorus (TP). The description that follows assumes that the NPS agrees that similar nutrient removal objectives are appropriate for the Kaloko Makai project.

Figure 2 is a schematic diagram of the wastewater treatment concept. The wastewater treatment plant would include the following processes:

Influent Pump Station: A pump station will be required to lift raw wastewater from the sewer system to the treatment processes.

Headworks: The headworks would include screening systems to remove debris and grit removal to remove inorganic particles (e.g., sand) from the waste stream. Grit and screenings will be disposed at the West Hawaii Landfill.

Biological Treatment: Organic matter and nutrients will be removed using an activated sludge process. The process will incorporate biological nutrient removal (BNR). BNR incorporates aerobic, anaerobic and anoxic zones within the treatment process and recycle flows to facilitate biological reduction of TN and TP to 10 mg/L and 2 mg/L, respectively. Clarifiers will be used to separate the activated sludge from the secondary effluent.

Coagulant Addition/Flocculation: Coagulants (such as aluminum sulfate and/or polymer) will be added to the secondary effluent downstream of the secondary clarifiers and mixed to combine small particles into larger "flocs" that can be removed in the filtration process.

Filtration: The filtration process will provide two treatment benefits: turbidity reduction to meet R-1 water recycling requirements, and additional nitrogen removal. Denitrification filters are available that are accepted by the California Department of Public Health (CDPH) for Title-22 recycled water production and are also capable of reducing TN concentrations to 5 mg/L via denitrification. The DOH allows the use of filtration processes that are accepted by CDPH for R-1 recycled water production. Addition of a carbon source (typically methanol) is required upstream of the filters to facilitate the denitrification process. The DOH

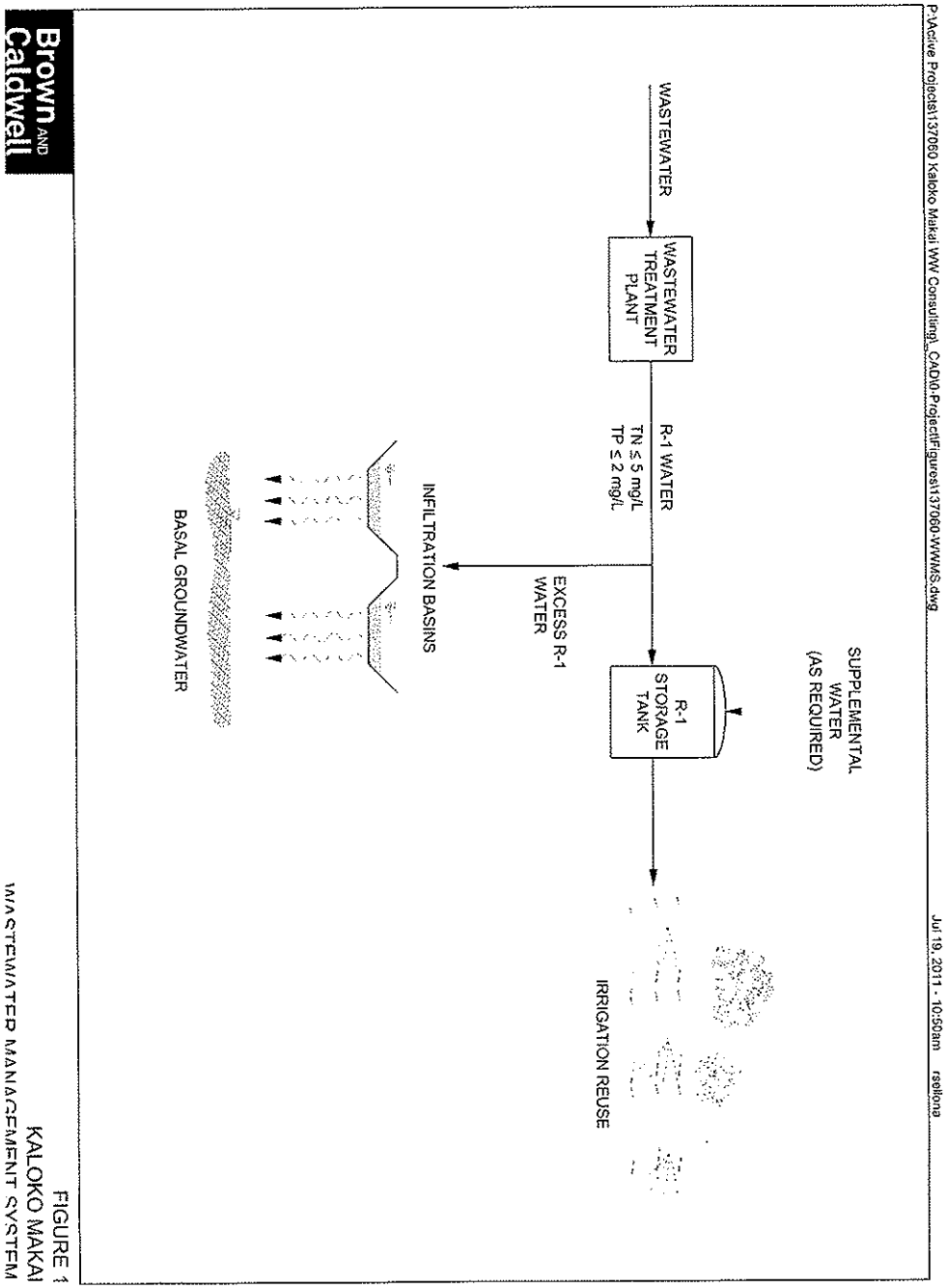

FIGURE 1
KALOKO MAKAI
WASTEWATER MANAGEMENT SYSTEM

requires that R-1 recycled water have effluent turbidity of less than 2.0 Nephelometric turbidity units (NTU) at all times.

Disinfection: The effluent will be disinfected with ultraviolent light (UV) to meet R-1 recycled water requirements. The DOH requires that R-1 recycled water have a median density of fecal coliform that does not exceed 2.2 per 100 mL.

Effluent Pump Station: An effluent pump station will deliver recycled water to the R-1 storage tank for reuse, or to the infiltration basins for disposal.

Aerobic Digester: Waste solids (sludge) from the biological treatment and filtration systems will be pumped to an aerobic digester system for stabilization and thickening via periodic decanting.

Mechanical Dewatering: Aerobically digested sludge will be mechanically dewatered prior being hauled offsite for disposal at the West Hawaii Landfill.

Water Recycling System

Potential acceptable uses for R-1 recycled water in the Project are listed in Table 1. Note that irrigation of single family residential parcels is not allowed by DOH.

Table 1. Potential R-1 Recycled Water Uses at Kaloko Makai

Landscape Irrigation	Industrial	Other
• Parks • School yards • Athletic fields • Road sides and medians • Commercial property (if managed by an irrigation supervisor) • Multi-family residential property (if managed by an irrigation supervisor)	• Commercial and public laundries • Industrial cooling • Industrial process water	• Toilet and urinal flushing in buildings with dual water systems • Decorative fountains • Street sweeping • Dust control

The DOH has restrictive requirements for R-1 irrigation on property located above of the Underground Injection Control (UIC) line (e.g., groundwater or vadose zone monitoring, no excess irrigation to flush salts below the root zone allowed), and therefore we recommend that R-1 reuse be limited to properties located below the UIC line. It appears that most of the development is located below the UIC line; however park P-1 and the upper elementary school may be located above the UIC line and should be irrigated with other water sources.

Based on other Kona-area evaluations, an average R-1 recycled water flow rate of 2.37 mgd has the potential to provide irrigation water for up to approximately 273 acres without routine supplemental water addition. The Kaloko Makai development concept includes 50 acres of parks and 30 acres of schools located below the UIC line that will likely be the largest users of recycled water. Only a portion of the park and school acreage will be irrigated; our preliminary estimate is that approximately 60 acres of the total park and school acreage will ultimately be irrigated. Additional recycled water users (e.g., streetscape, multi-family residential, etc.) can be added to the system if they are located near the distribution lines that carry the water to the largest users.

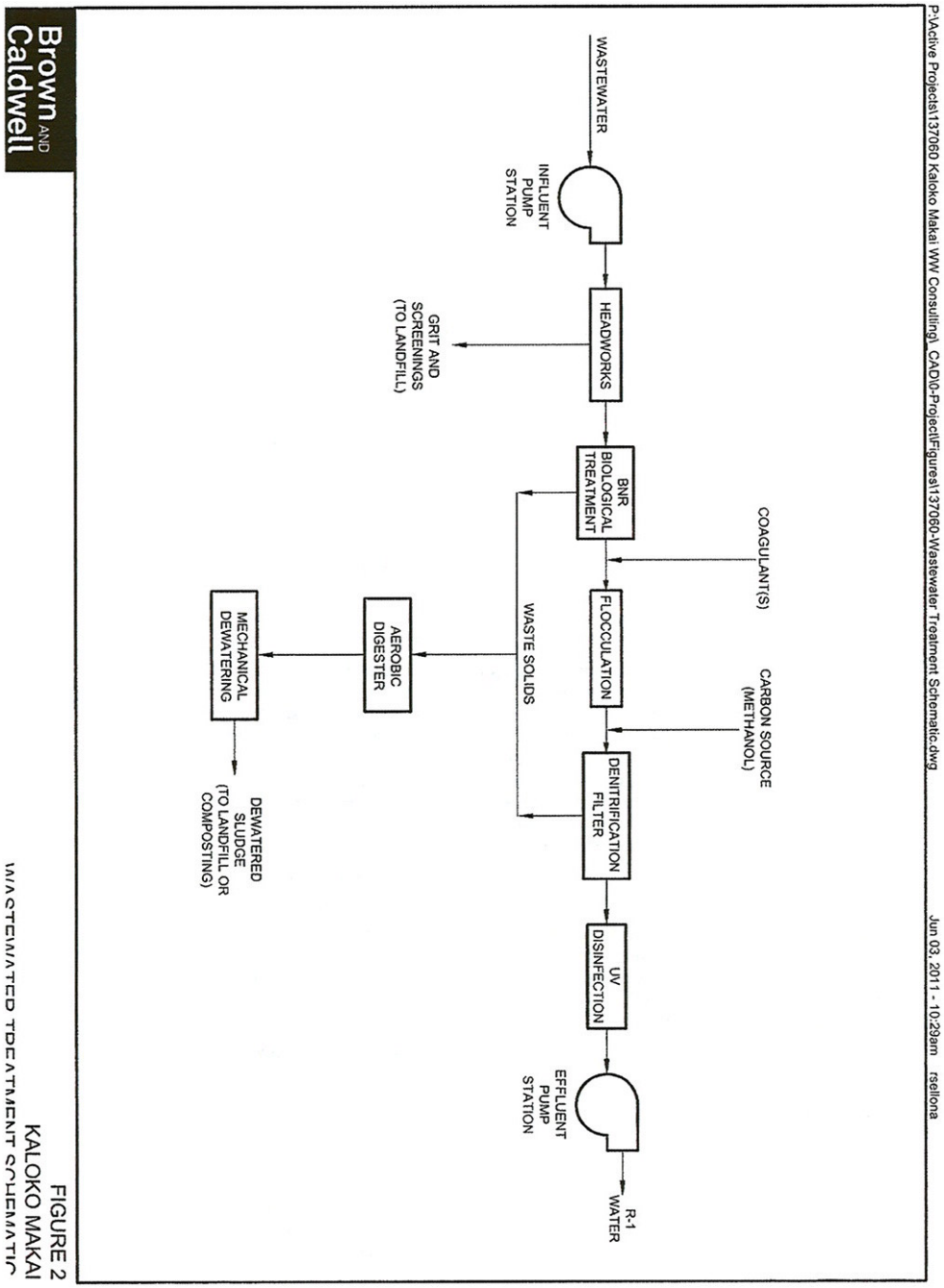

FIGURE 2
KALOKO MAKAI
WASTEWATER TREATMENT SCHEMATIC

The required R-1 storage tank size will be based on the peak day demand of the recycled water uses.

Supplemental Water

There may be times when R-1 supplies are not sufficient to meet the irrigation demands of the parcels that are connected to the R-1 distribution system. For example, in the first development phase there will likely be not enough R-1 water to irrigate the parks and schools that are slated for construction. Therefore, addition of supplemental water (potable or non-potable) to the R-1 storage tank will be required to ensure the irrigation demands can be met.

Disposal System

There will be times when there is more R-1 water available than the irrigation users require; for example, during periods of extended wet weather. The DOH requires that a disposal system be provided for when recycled water supply exceeds the demand. The United States Department of Agriculture Natural Resources Conservation Service Soil Survey indicates that Aa lava is present at the proposed wastewater treatment plant location. Aa lava is typically extremely porous, and significant volumes of water can be disposed in a relatively small area via percolation basins. Percolation basins are currently used at the Kealakehe Wastewater Treatment Plant and at the Waikoloa Resort Wastewater Treatment Plant for disposal purposes.

Please call me at (808) 442-3301 if you have any questions.

Very truly yours,

Brown and Caldwell

Craig C. Lekven, PE (Hawaii License No. 13003, Expires 4/30/12)
Supervising Engineer

CCL:ic

cc: Mr. Earl Matsukawa, Wilson Okamoto Corporation

Appendix S

EISPN Comment and Response Letters

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

EM

In Reply Refer To:
2010-TA-0513

NOV 04 2010

OCT 29 2010

Mr. Earl Matsukawa, AICP
Project Manager
Wilson Okamoto Corporation
19070 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

Subject: Environmental Impact Statement Preparation Notice for Kaloko Makai, North Kona, Island of Hawaii

Dear Mr. Matsukawa:

The U. S. Fish and Wildlife Service (Service) has reviewed the Environmental Impact Statement Preparation Notice (EISPN) for the Kaloko Makai project located north of Kailua-Kona on the island of Hawaii. We received your letter soliciting our comments on September 20, 2010. On October 18, 2010, Jeff Zimpfer, from my staff, asked for a one-week extension to provide comments. We thank you for granting us a one-week extension. At build-out, this master-planned community will have 5,000 single-family and multi-family residences, commercial centers, schools, community services and supporting infrastructure. This project will be located on 1,142 acres of land that is currently undeveloped. Through our involvement with the federally funded Ane Keohokalole Highway project in Kona, we have been working with representatives from Stanford Carr Development to develop measures to avoid and minimize impacts to listed and rare species in the vicinity of this project. We have reviewed the project information you provided and pertinent information in our files, including data compiled by the Hawaii Biodiversity and Mapping Program and the Hawaii GAP Program. The following endangered plants currently occur on the site of the proposed project: (1) aiea (*Nothocestrum breveflorum*); (2) uhiuhi (*Caesalpinia kavaiense*); (3) maoloa (*Neraudia ovata*); and (4) hala pepe (*Pleomele hawaiiensis*). The candidate taxon for listing, kookoolau (*Bidens micrantha* ssp. *ctenophylla*), also occurs occur on the site of the proposed project. The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) and Blackburn's sphinx moth (*Manduca blackburni*) are known to occur in the vicinity of the proposed project and may occur within the area proposed for development. We recommend you address potential project impacts to the sensitive native ecosystems and listed species discussed below, and include measures to minimize adverse impacts to these resources in your Draft Environmental Impact Statement (DEIS).

TAKE PRIDE IN AMERICA

General Comments

- Based on our discussions with representatives from Stanford Carr Development, 150 acres of dryland forest will be set aside for a preserve in perpetuity. In addition, the developer will work with the State of Hawaii to develop a Habitat Conservation Plan (HCP) for impacts to State-listed plants that occur on lands within the project footprint but are not included in the dryland forest preserve, specifically hala pepe. In addition to developing a HCP for hala pepe, we recommend that you include kookoolau in your HCP, as this candidate for listing may become federally and State listed before this project is completed. We understand that the developers of this project will also work to maintain and restore the ecological integrity of the dryland forest. We also understand that the developer will allow natural resource professionals and organizations access to the dryland forest to do appropriate conservation work. We recommend you prepare and implement a management plan for the dryland forest preserve that includes conservation actions such as fencing and invasive species control. A source of funding for the implementation of the management plan should also identified in the DEIS and offer our ongoing technical assistance.

- At build-out, this proposed project could potentially impact the Keauhou aquifer. The Service is concerned that the long-term demand for water from the Keauhou aquifer system would exceed the aquifer's sustainable yield and result in increased salinity of wetlands, fishponds, anchialine pools, and coastal waters in the Kaloko-Honokahau National Park. Three candidate species for listing, including two shrimp (*Metabetaeus lohena* and *Palaemonella burnsi*), and a damselfly (*Megalagrion xanthomelas*), and two endangered waterbirds, the Hawaiian stilt (*Himantopus mexicanus knudseni*) and Hawaiian coot (*Fulica alai*), depend on these aquatic ecosystems and may be adversely impacted by increases in salinity. The cumulative impacts of development in the area surrounding the Kaloko-Honokahau Park should be addressed in the DEIS.

- Hawaii's native ecosystems are heavily impacted by exotic invasive plants. Whenever possible we recommend using native plants for landscaping purposes. If native plants do not meet your landscaping objectives, we recommend that you choose species that are thought to have a low risk of becoming invasive. The following websites would be good resources to use when choosing landscaping plants: Pacific Island Ecosystems at Risk (http://www.hear.org/Pier/), Hawaii-Pacific Weed Risk Assessment (http://www.botany.hawaii.edu/faculty/daehler/wra/full_table.asp) and Global Compendium of Weeds (www.hear.org/gcw).

- To further minimize project impacts to listed species occurring in the project vicinity, we recommend prohibiting free movement of pets, implement public education to discourage the feeding of feral animals, especially cats, and install sturdy animal-proof garbage containers to prevent increases in the populations of house mice, rats, mongoose, and feral cats. These measures should also be incorporated into any Community Rules and Regulations instituted for the Kaloko Makai development.

- The proposed project is located on the dry leeward side of the island of Hawaii where wildland fires interdependent with the proposed project may affect federally listed upland

species. The West Hawaii Wildfire Management Organization was formed to support efforts to coordinate development of area firebreaks, a system of fire suppression helicopter dip-sites, and fire prevention materials to minimize impacts of fires associated with increases in the West Hawaii population. We recommend you contact this organization for further information regarding your project and potential wildland fire issues.

Specific Comments

Page 3-11 of the EISPN states:

> "The 150-acre native dryland forest is located within the southern portion of the project site and is one of the last dryland forests still relatively free of introduced, alien grasses and cattle. This patch of forest was home to at least four endangered plant species aiea (*Nothcocestrum breviflorum*), maoloa (*Neraudia ovata*), *Cyperus faurieri*, and hala pepe (*Pleomele hawaiiensis*). Twenty five native species were observed within the dryland forest, eleven of them endemic to Hawaii. Four of these (three found during previous surveys only and one during this survey) are Federally listed endangered species."

We would like to clarify that aiea, maoloa, and hala pepe do currently occur in the dryland forest on the project site. The aiea occurs in an area outside of the proposed dryland forest preserve and hale pepe occurs both inside and outside the proposed dryland forest preserve. In addition, uhiuhi also occurs in the proposed dryland forest preserve.

We appreciate the opportunity to provide technical assistance in your environmental compliance process for this project. If you have any questions regarding this letter, please contact Dr. Jeff Zimpfer, Fish and Wildlife Biologist, Consultation and Habitat Conservation Planning Program (phone: 808-792-9431; email: jeff_zimpfer@fws.gov).

Sincerely,

for Loyal Mehrhoff
Field Supervisor

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Dr. Loyal Mehrhoff, Field Supervisor
U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, HI 96850

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Dr. Mehrhoff:

Thank you for you letter dated October 29, 2010 (2010-TA-0513). We offer the following responses in the respective order of your comments:

1. We acknowledge that the following four federally listed endangered species, `aiea (*Nothocestrum breviflorum*), ma`oloa (*Neraudia ovata*), hala pepe (*Pleomele hawaiiensis*), and uhiuhi (*Caesalpinia kavaiensis)* are located within the 150- acre native dryland forest within Kaloko Makai project site. Additionally, ko`oko`olau (*Bidens micrantha* spp. *ctenophylla)* which is a candidate species for listing, is also present within the Kaloko dryland forest.

   Kaloko Makai has been working with the US Fish & Wildlife Service and the Department of Land and Natural Resources (DLNR) on the delineation and preservation of the 150 acre native dryland forest. In the future, we look forward to working with you to develop a management plans for the dryland forest.

   Kaloko Makai has determined that the project may cause the taking of two listed plant species (`aiea and hala pepe) and one candidate species (ko`oko`olau). In response to this, Kaloko Makai prepared a Habitat Conservation Plan (HCP) with the Department of Land and Natural Resources to address the short- and long-term management measures to protect these species. DLNR is presenting reviewing the HCP.

   A botanical survey was conducted and will be included in the Draft EIS.

2. We acknowledge that the Hawaiian hoary bat and Blackburn's sphinx moth are known to occur in the vicinity of the project area. Avifauna, mammalian, and invertebrate surveys were conducted and will be included in the Draft EIS.

3. We acknowledge that the Service has concerns about the long-term demand on the Keauhou Aquifer and impacts on coastal resources. Discussion of impacts and mitigation measures on groundwater and coastal resources will be included in the Draft EIS.

In addition, Kaloko Makai shall develop a pollution prevention plan (PPP) that provides Best Management Practices (BMPs), including structural BMPs, for pollution prevention that address all categories of permitted uses within the Project, and shall address environmental stewardship and the non-point sources of water pollution that can be generated from any uses allowed within the Project. Emphasis shall be given to BMPs that prevent or limit pollutants arising out of the permitted uses within the Project from reaching the groundwater and ocean.

4. Wherever possible, native plants will be used for landscaping throughout Kaloko Makai. We appreciate the referrals to resources regarding native plant species.

5. While prohibiting the free movement of pets could not be achieved at Kaloko Makai's discretion, a public education program will be developed to encourage confinement of pets, discourage the feeding of feral animals and promoting the installation of animal proof garbage containers to prevent increases in rodent populations.

6. We will consult with the West Hawaii Wildfire Management Organization to coordinate development of area firebreaks, wildland fire dip tanks, and fire prevention materials to minimize impacts of wildland fires.

7. As previously mentioned, we acknowledge that `aiea, ma`oloa, hala pepe, and uhiuhi are located within the 150-acre native dryland forest on the Kaloko Makai project site. The flora section will be revised to reflect this.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

United States Department of the Interior
NATIONAL PARK SERVICE
Kaloko-Honokohau National Historical Park
73-4786 Kanalani St., Suite 14
Kailua-Kona, HI 96740

IN REPLY REFER TO:
L7621

October 22, 2010

Mr. Earl Matsukawa, AICP
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

RE: National Park Service Review of the EA/EIS Preparation Notice, Kaloko Makai Project, Kaloko, North Kona, Island of Hawaii

Dear Mr. Matsukawa:

Thank you for the opportunity to provide input to the preparation of an Environmental Assessment/Environmental Impact Statement (EISPN) for the proposed Kaloko Makai development. This proposed development will be a 1,142-acre, master-planned, mixed-use residential community with up to 5,000 new single and multi-family residential units, approximately 153 acres of light-industrial/commercial/retail, an urgent care medical facility with potential for a regional hospital, two elementary schools, a middle school, a wastewater treatment plant, associated roadways, utilities, drainage, and water source and distribution system. Kaloko-Honokohau National Historical Park is located immediately across Queen Ka'ahumanu Highway, from the proposed project site. A development of this magnitude upslope and essentially adjacent to the National Park will significantly, and irreversibly affect park resources. Therefore the National Park Service (NPS) requests that we be a formally consulted party during the EIS process.

The National Park Service is charged with preserving the nationally significant cultural and natural resources found within Kaloko-Honokohau National Historical Park. The National Park was established in 1978 "to provide a center for the preservation, interpretation, and perpetuation of traditional native Hawaiian activities and culture, and to demonstrate historic land use patterns as well as to provide a needed resource for the education, enjoyment, appreciation of such traditional native Hawaiian activities and culture by local residents and visitors." (Public Law 95-625). The authorization was based on a study and report by a congressional advisory commission comprised of Native Hawaiians. The study recommended that the site that is the Honokohau Settlement National Historical Landmark (designated in 1962) and its adjacent waters be preserved for the benefit of the Hawaiian people and the nation as part of the national park system. Water quality and quantity are critical to this mission and to the integrity of the Park. The National Park contains two large (11 and 15- acre) ancient Hawaiian fishponds both with associated wetlands, more than 185 known anchialine pools, and 627 acres of marine habitat. These waters define the National Park. They are significant cultural resources and

also provide habitat for ten threatened, endangered, and candidate species. The National Park and the National Historic Landmark share the same boundaries. Page 1-7 of the EISPN should be corrected to reflect the fact that all park lands are within the Honokohau Settlement National Historic Landmark.

The National Park water resources are fed by, and in the case of the anchialine pools are dependent upon, groundwater input. The anchialine pools support three known candidate endangered species. 'Aimakapa Fishpond receives significant groundwater inputs and is important foraging and nesting habitat for the endangered Hawaiian stilt and the Hawaiian coot, and is also an important habitat for migratory waterfowl. The US Fish and Wildlife Service considers 'Aimakapa to be a "core wetland" in the recovery of these species[1]. The EISPN incorrectly states in Section 3.4 (p. 3-6) that 'Aimakapa is separated from the ocean by a basaltic rock wall. 'Aimakapa is closed to the ocean by a sand berm, and receives significant groundwater inputs resulting in lower salinity waters.

The EISPN also incorrectly states (p. 3-6) that *"there are no wetlands located ... in the immediate vicinity of the project site."* Kaloko Fishpond is within ½ mile of the project site. The EISPN incorrectly omits on page 3-6 that Kaloko Fishpond has approximately eight acres of associated wetlands. 'Aimakapa Fishpond and wetlands are also within the immediate vicinity of the project site. Kaloko Fishpond is in the process of being restored for productive, traditional aquaculture use for human consumption as part of the Park's Cultural Live-in Center project and has open connection to the sea. Kaloko Fishpond is used by the Hawaiian stilt for foraging and occasional nesting attempts. The Park's marine waters are inhabited by resident juvenile green sea turtles (listed as "threatened"), and the endangered hawksbill sea turtle. The endangered Hawaiian monk seal is an occasional visitor to Park waters and rests on the shoreline. The candidate endangered Hawaiian false killer whale is known to utilize park waters, and endangered Humpback whales are seasonally within Park waters.

Surface Water Drainage, Non-point Source Pollution

The waters of the National Park will be the receiving waters of this development, during and following construction. Preservation of the quality of groundwater entering Kaloko-Honokohau National Historical Park is a significant concern. Traditional and customary Native Hawaiian practices within the National Park rely heavily on the quality and quantity of the groundwater. Studies completed by the US Geological Survey in the Park[2] indicate that water resources in the National Park are vulnerable to upslope ground-water contamination. Water quality directly affects cultural resources within the Park. Degradation of fishpond waters may affect the health of endangered waterbirds, and the abundance and/or health of fish, which are harvested for human consumption, potentially affecting human-health. Kahinihini'ula, and other culturally important anchialine pools could also be adversely affected by negative changes to water quality. Nonpoint source pollutants also affect the marine environment, coral populations, and coral

[1] U.S. Fish and Wildlife Service. 2005. Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Draft of Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon. 155 pp.
[2] Oki et al. 1999. Ground Water Resources in Kaloko-Honokohau National Historical Park, Island of Hawaii, and Numerical Simulation of the Effects of Ground-Water Withdrawals, U.S. Geological Survey Water-Resources Investigation Report 99-4070. U.S. Geological Survey, Honolulu, HI. 49 pp.

ecosystems in a variety of ways, including reducing the recruitment of new corals, interfering with coral reproduction, affecting coral calcification rates, and altering species composition.

Because of the high permeability of the site and the interconnection of surface activity and groundwater resources, polluted groundwater has the potential to have significant negative impacts to the National Park's water resources and the marine environment. However, Section 3.5 states "[a]*ny project impacts anticipated upon water quality will be subject to natural processes that occur based on vertical travel distance of the infiltrated water and horizontal distance to the ocean.*" This statement appears to suggest that simple, unenhanced infiltration will solely be relied upon to mitigate contamination to groundwater. In a highly permeable environment with little or no soil (see EISPN Section 3.3) such as the project site, this level of mitigation is unacceptable. According to the Environmental Protection Agency's 1993 Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, one of the objectives of urban runoff management is "protection of ground water resources" (p. 4-5). The EPA Guidance says "infiltration systems [standard drywells, such as those used in West Hawaii] may not be appropriate where groundwater requires protection" (p. 4-14). This EPA Guidance remains an active, relevant document, issued by the EPA under the authority of Section 6217(g) of the Coastal Zone Act Reauthorization Amendments for application throughout the country, including Hawaii.

In 2001 the state Land Use Commission (LUC) recognized the potential adverse impacts of upslope development and the legal and constitutional obligation to protect and preserve the resources of the National Park.

The LUC expressly determined that:

> [N]ative Hawaiian rights and natural and cultural resources would be damaged or destroyed by the pollution of groundwater that reaches the National Park from surrounding areas, including proposed development at the Kaloko Industrial Park. Appropriate mitigation measures are, therefore, required under the Hawaii Constitution . . . in order to approve reclassification of the project area. (LUC 2002, Docket A00-732 Findings of Fact Conclusions of Law Decision and Order; Conclusion of Law ¶ 7)

The EIS should contain a thorough and rigorous analysis of potential impacts, direct and cumulative, to groundwater and groundwater-fed ecosystems from termiticides and pesticides used on houses, buildings, grounds, and common areas; added nutrients from irrigation and fertilized green spaces; potential releases of contaminants from commercial businesses in the light-industrial/commercial parks who generate hazardous wastes (e.g., metal finishing, photo-processing, automotive maintenance, dentistry, pesticide companies, printing, etc); potential releases of medical wastes, pathogens, and pharmaceuticals from the medical facilities; nutrients, pathogens, and pharmaceuticals carried in wastewater; contaminants associated with roadways and other impermeable surfaces including petroleum products, metals, pesticides, nutrients, and other pollutants. The EIS should discuss in detail how it will protect downslope park resources and receiving waters from these significant threats.

The EIS should include, as mentioned in the EISPN section 3.4, a full analysis of drainage construction techniques beyond what are required by the county and state, such as filtered drainage systems appropriately and specifically engineered to be effective in Kona's arid, low soil environment to reduce non-point source pollution to the groundwater and marine waters. We note that design specifications of drainage wells in compliance with the Hawaii County Public Works and State Department of Health standards do not inherently incorporate any structure or other design feature to remove petroleum, oil, nutrients, or any contaminants contained in runoff. Hawaii County codes for drainage wells do not address protection of significant environmental resources, but rather solely consider flood control and volume of runoff. There is no State law or County code currently in place to ensure that pollutants carried with surface runoff below the UIC line do not get into the environment through groundwater.

Water System

Section 3.17.1, Water System, states that the proposed project's water demand will require the construction of additional water sources. No estimate of the quantity of potable and irrigation water required for the project is provided and the location of the future water supply well is not identified. Additionally, there is discussion at 3.16.2 regarding Fire Protection but no discussion of the source of water for the system proposed (all appurtenances, hydrants and fire flow requirements).

The general effects of pumping groundwater in the area of Kaloko-Honokohau NHP will include a decline in water levels, a rise in underlying saltwater and eventually, a reduction in groundwater discharge to the ocean. The magnitude and timing of these effects on specific groundwater-dependent resources in the Park will depend upon the pumping rate and the location of the pumping wells.

If a standard of 400 gallons per day per housing unit is used, water demand for the proposed project could be as high as 2.0 million gallons per day. If higher elevation groundwater in the vicinity of the proposed project is to be the water source, then the water supply well may be located directly upgradient of the Park.

The Kaloko-Honokohau NHP ground-water study, referenced above, as well as one for the entire Kona area,[3] addresses the potential for decreased ground water levels because of increased water withdrawals. Changes in the level, temperature, and salinity of groundwater in the Park's fishponds, anchialine pools, and nearshore ecosystems have the potential to adversely affect the species that inhabit these areas. Native Hawaiians continue to rely on inland and nearshore waters for traditional and customary uses. Therefore, a reduction in groundwater discharge may also adversely affect the traditional uses of these natural/cultural resources within the Park.

Because an irrevocable commitment of groundwater resources will be made for this project, the planned groundwater resources and marine water quality assessment noted on page 3-9 should identify the potable and non-potable water demand for the proposed project and the source of

[3] Oki et al. 1999. Geohydrology and Numerical Simulation of the Ground-Water Flow System of Kona, Island of Hawaii; U.S. Geological Survey Water-Resources Investigations Report 99-4073. U.S. Geological Survey, Honolulu, HI. 70 pp.

this water, and should include a detailed analysis of the impacts, direct and cumulative, of these water withdrawals on groundwater dependent cultural and natural resources at the coast. A quantitative analysis of the potential changes to groundwater flow and quality within the aquifer system must be made to identify impacts on the National Park inland and nearshore marine waters. The EIS should detail how the project will incorporate water conservation.

Wastewater System

Park biological and cultural resources are affected by current development upslope of the Park because of inadequate systems for removing nutrients, pharmaceuticals, and contaminants from wastewater before they enter the groundwater system. The proposed wastewater treatment plant shown on Figure 2-1 located immediately across the highway from the National Park is not acceptable to the National Park Service. The proposed methods for dealing with wastewater treatment and effluent and the resulting direct and cumulative impacts should be analyzed in the EIS. Septic systems should not be considered for the proposed project. Additionally, methods of disposal of medical wastes and prevention of accidental releases of hazardous wastes from the medical facilities should be described in detail.

Roadway System and Traffic

The proposed Kaloko Makai development will create significant additional traffic and noise increases on Queen Ka`ahumanu Highway and at access points to the National Park and park headquarters. The EIS should analyze the effects of the increase in traffic, including direct, indirect, and cumulative impacts to visitors accessing the National Park, and the measures planned to alleviate traffic congestion, including a detailed discussion of the proposed interchange connecting Kaloko Makai with the Queen Ka`ahumanu Highway as mentioned on page 3-26 and shown in figure 2-1. Additional information in the EIS should update the status of current road widening projects, roadway expansion, and signalization.

Noise

An analysis of direct and cumulative increased noise generated by the project during both the construction and final build-out phase on the the soundscape within the National Park should be included in the EIS. The EIS should also discuss the impacts of the future development of the short austere runway at Keahole-Kona Airport. Additionally, there is a need to update and incorporate the Kona International Airport Master Plan and Part 150 Noise Compatibility Study Update, which is now completed and discusses increased noise, and night/day flight factors that will have an impact on the area and the proposed development.

Air Quality

Local air patterns and some pollution sources are described in the preparation notice. The prevalent wind system in the proposed project area is *mauka – makai*, nighttime and morning offshore winds changing to onshore during the day. Poor air quality resulting from volcanic emissions, airport emissions, highway traffic emissions, and fugitive dust from multiple ongoing construction sites and from quarries within a mile of the proposed site is not readily moved away from the area. Cumulative air quality impacts from the construction of this project as well as the additional cars residing in the final development, potentially 1.9 cars/household,[4] must be

[4] Bureau of Transportation Statistics 2001, www.bts.gov

considered in conjunction with the Queen Ka`ahumanu Highway expansion, expansion of the airport, addition of the short austere airfield runway and proposed military training routes over the area, and construction of multiple industrial parks in the area. A quantitative analysis of air quality and cumulative impacts should be made in the EIS. Because the volcanic emissions, which cannot be controlled, consistently degrade air quality in Kona, those new anthropogenic sources of PM2.5 (e.g. automobiles) must be controlled wherever possible. The EIS should discuss how new sources will be controlled and appropriate mitigations for improving post-construction air quality. As this area transitions into a larger population center, air quality and its effect on human health is an increasingly important issue that must be addressed.

Visual Resources

Changes to the viewshed, nightsky (light pollution), topography, and vegetation within the *ahupua`a* will adversely affect the cultural landscape of the National Park. The EISPN does not include in its Impacts and Mitigation Measures (page 3-19) any discussion of impacts to *mauka* views from the National Park. Hawaiian land-use developed and relied upon the *ahupua`a* concept of land tenure and stewardship. Cultural, natural and spiritual aspects of the ahupua'a are all critical components in the Park's mission to perpetuate the Hawaiian culture. The EIS should include a viewshed analysis from the National Park looking *mauka* to examine and analyze direct and cumulative impacts to cultural landscape, park viewshed, and nightsky, and a description of how these impacts will be mitigated. The EIS should also include a more detailed analysis of building designs that will minimize viewshed impacts and will blend the development into the landscape, as well as including discussion of appropriate plantings to reduce these visual impacts.

Archeological and Cultural Resources:

At Section 3.11, the listing of archeological and cultural resources, historic districts and sites should also include the Kaloko-Honokohau National Historic Landmark designation (Honokohau Settlement). In addition, there should be discussion in the EIS regarding early consultation and engagement with lineal descendants and the Native Hawaiian community specifically about the development plans and archeological/cultural resources, cultural landscapes, and potential places of significance within the proposed development area.

Preservation/Open Space and Connectivity to the National Park

Kaloko-Honokohau National Historical Park is connected culturally, and through natural processes, to the ahupua`a in which it sits. The EIS should describe how the proposed project will preserve and foster connectivity with the National Park and the Ala Kahakai National Historic Trail. The EISPN discusses preserving and protecting archeological sites, the Road to the Sea, establishing open space and preserving coastal dryland forest. These features are integral parts of the cultural landscape of the Park and the ahupua`a.

Impacts to Coastal and Recreational Resources

The proposed project will significantly increase pressure by people on recreational facilities and coastal resources in the area. The National Park is the closest coastal access for this community and will bear the majority of the pressure, particularly through the connectivity mentioned above. Section 3.16.5, Recreational Facilities Impacts and Mitigation Measures (page 3-22) does not mention analysis of impacts to coastal and recreational resources stemming from use by this

proposed community. The EIS should analyze direct and cumulative effects of 5000 additional resident families (potentially 20,000 people) utilizing the National Park and its coastal resources. This analysis should include direct, indirect, and cumulative impacts resulting from recreational uses on the National Park's law enforcement and visitor services, the park's future Cultural Live-in Center, archeological sites, fisheries, fish, coral, and protected species inhabiting nearshore waters and beaches.

Contextual Issues, Cumulative Impacts

Contextual issues and cumulative impacts are very important and should be thoroughly addressed in the EIS. The existing and proposed developments around the project have environmental review documents, including the EIS for the National Park. These documents should be consulted and the cumulative impacts of the proposed project in the context of these proposed or approved developments (e.g., airport expansion, Air Force military training routes and the short austere air field, Queen Ka`ahumanu Highway expansion, Queen Lili`uokolani Trust, The Shores at Kohanaiki, O`oma Beachside Village, West Hawaii Business Park, Kaloko Phases III and IV, Kaloko Heights, Honokohau Makai, Ane Keohokalole Highway, Kamakana Village, La`i`Opua Villages and others) should be analyzed with regard to the impacts cultural and natural resources, visitors, and cultural practitioners in the area. Cumulative, direct and indirect impacts that will affect Park resources, visitors and those engaged in traditional and cultural practices, particularly, traffic, noise, air pollution, nightsky light pollution, mauka viewshed, increased park visitation, coastal recreational use, and the quality and quantity of ground water resources, must be considered.

General Content and Map Presentation:

Public participation is the foundation of the Hawaii Environmental Protection Act. In order for the public to make informed decisions regarding this proposed project, they must be made fully aware of the resources at risk and their location. None of the figures in the EISPN display the national park boundary or its federal status. County and State zoning are not applicable on federal property whose title is held by the federal government. All maps and graphics in the EIS, including the conceptual land use maps, must accurately show the location of the legislated boundary of Kaloko-Honokohau National Historical Park, the National Historic Landmark boundary, and must include a federal land designation.

The County GIS correctly indicates the federal lands at Pu'uhonua O Honaunau NHP and Hawaii Volcanoes National Park; however the County zoning designation incorrectly shows the federal park-lands zoned as "Open." The State GIS also incorrectly shows the federal park-lands zoned as "Urban" and the park shoreline as "Conservation." These designations were zoned prior to federal ownership and no longer apply. All federal lands indicated in the EIS graphics should show federal lands designation and no zoning as County and State zoning are not applicable on federal property whose title is held by the federal government. State and private parcels encompassed within the authorized boundary of the National Park should be shown as such.

Additionally, we believe that the FEMA FIRM maps (page 7-6) have been updated more recently than April 2004. Likewise the EIS should reflect more current versions of the Hawaii County Data Book and U.S. Census information.

Thank you for the opportunity to provide these comments early in your environmental review process. To receive a copy of the national park boundary and federal lands GIS shapefiles, or if you have questions on these comments, please contact me at 808-329-6881 x1201, kathy_billings@nps.gov, or Sallie Beavers, Chief of Resources Management at x 1220, sallie_beavers@nps.gov.

Sincerely,

Kathy Billings

Kathy Billings
Superintendent

cc: Office of Environmental Quality Control
Stanford Carr Development, LLC
County of Hawaii Planning Department
County of Hawaii Department of Water Supply
Commission on Water Resources Management
State Office of Planning
Hawaii Department of Health
State of Hawaii Land Use Commission
State of Hawaii Historic Preservation Division
US Fish and Wildlife Service
National Marine Fisheries Service
Office of Hawaiian Affairs
Makani Hou o Kaloko-Honokohau
Na Kokua o Kaloko-Honokohau
NPS Pacific West Regional Office

WILSON OKAMOTO CORPORATION
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Honolulu, Hawaii, 96826 USA
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7469-01
July 25, 2011

Ms. Kathy Billings, Superintendent
U.S. National Park Service
Kaloko-Honokohau National Historic Park
73-4786 Kanalani Street, Suite 14
Kailua-Kona, HI 96740

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Ms. Billings:

Thank you for your letter dates October 22, 2010 (L7621). We offer the following responses in the respective order of your comments:

1. We acknowledge the Kaloko-Honokohau National Historical Park contains two large fishponds, 185 anchialine ponds, and 627 acres of marine habitat. Section 3.5 in the Draft EIS will include the information you provided.

2. Section 3.5 in the Draft EIS will state "Aimakapa is closed to the ocean by a sand berm…"

3. The Draft EIS will reflect the recommended changes to identifying resources located in the vicinity of the project site.

4. Surface Water Drainage, Non-Point Source Pollution: The Draft EIS will discuss drainage, non-point source pollution, and the potential impact to groundwater resources and the nearshore marine environment and mitigation measures. An analysis of potential impacts to groundwater and ground-water fed ecosystems needs to be based on evidence that such impacts are likely to occur. This analysis based on available data and understanding of the hydrology of the area will be provided in the Draft EIS.

   Based on the aforementioned analysis, appropriate mitigation measures will be recommended to minimize urban runoff and to protect groundwater resources.

5. Water System: Kaloko Makai's water demand will require development of additional water sources, storage and transmission facilities. Kaloko Makai is investigating several alternatives to address its potable water needs. The Draft EIS will discuss the proposed project's demands, alternative water sources and the potential impact to ground water resources and the nearshore marine environment associated with the development of the alternative sources.

   Estimates on potable water, non-potable water demand and irrigation will be included in the Draft EIS. Within the Kaloko Makai project, fire flow and fire protection shall be in accordance with UFC Section 10.301(c).

6. Wastewater System: In the event connection to a public wastewater system is not available, Kaloko Makai will construct and operate a Private Wastewater Treatment Plant (WWTP) within the project. The Kaloko Makai facility will treat the wastewater to produce reclaimed (R-1) quality water for general irrigation within Kaloko Makai, thus lessening the demand for potable water. The Draft EIS will discuss potential impacts on groundwater resources and mitigation measures, including additional requirements for treatment and disposal of medical wastes.

7. Roadway System and Traffic: The Draft EIS will include a Traffic Impact Assessment Report (TIAR) that will address access and traffic issues, as well as recommend mitigation measures for potential adverse impacts.

8. Noise: The Draft EIS will include a Noise Study that will address potential short-term and long-term noise impacts generated by the project, as well as proposed mitigation measures for any potential impacts. The findings of the Kona International Airport Master Plan and Part 150 Noise Compatibility Study Update will be considered.

9. Air Quality: The Draft EIS will include an Air Quality Study that will address potential short-term and long-term air quality impacts, as well as recommended mitigation measures for potential adverse impacts.

10. Visual Resources: We acknowledge the view plane along Queen Kaahumanu looking both mauka and makai is an area of natural beauty. The Draft EIS will include a discussion on visual impacts.

11. Archaeological and Cultural Resources: An Archaeological Inventory Study and Cultural Impact Assessment have been prepared and will be summarized in the Draft EIS.

    Kaloko-Honokohau National Historic Landmark will be added to the listing of archaeological and cultural resources in Section 3.11.

12. Preservation/Open Space and Connectivity to National Park: The Draft EIS will discuss how the proposed project will foster connectivity with the National Park and Ala Kahakai National Historical Trail. Several resources, such as the Dryland Forest and Kohanaiki Trail (Road to the Sea), are located within the project site and will be preserved. Impacts and potential mitigation measures will be discussed in the Draft EIS.

13. Coastal and Recreational Resources: The Draft EIS will include a discussion on potential impacts on coastal and recreation resources and potential mitigation measures. Certainly the Kaloko-Honokohau National Historic Park is an important recreational resource and the proximity to the Kaloko Makai development increases visitation to some degree. The project, however, will also provide opportunities for active and passive recreation. Unless the Kaloko-Honokohau National Historic Park significantly changes the type of recreational activity it offers, however, its relative attraction as a regional passive recreational resource in the area, would not change significantly.

14. Contextual Issues, Cumulative Impacts: The Draft EIS will include a discussion on current and/or proposed developments in the project area. Each topic/section provides information on existing conditions, its potential impacts, and mitigation measures. A section on cumulative, direct and indirect impacts will be included in the Draft EIS.

15. General Content and Map Presentation: Graphics will highlight Kaloko-Honokohau National Historical Park, where appropriate.

16. FEMA: The FEMA FIRM Map will be updated and the correct Community Panel Number will be referenced.

17. Data: The Draft EIS will reflect most recent version of the Hawaii County Book and US Census data.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

United States Department of the Interior

NATIONAL PARK SERVICE
Ala Kahakai National Historic Trail
73-4786 Kanalani St., Suite 14
Kailua-Kona, HI 96740

IN REPLY REFER TO:
L7621

RECEIVED
OCT 27 2010

October 22, 2010

Mr. Earl Matsukawa, AICP
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

RE: National Park Service – Ala Kahakai National Historical Trail - Review of the EA/EIS Preparation Notice, Kaloko Makai Project, Kaloko, North Kona, Island of Hawaii

Dear Mr. Matsukawa:

Thank you for the opportunity to provide input to the preparation of an Environmental Assessment/Environmental Impact Statement (EISPN) for the proposed Kaloko Makai development. This proposed development will be a 1,142-acre, master-planned, mixed-use residential community with up to 5,000 new single and multi-family residential units, approximately 153 acres of light-industrial/commercial/retail, an urgent care medical facility with potential for a regional hospital, two elementary schools, a middle school, a wastewater treatment plant, associated roadways, utilities, drainage, and water source and distribution system.

The National Park Service (NPS) administers the Ala Kahakai National Historic Trail (NHT), which was added to the National Trails System by the U.S. Congress on November 13, 2000 (Public Law 106-509). The legislation authorizing the Ala Kahakai NHT identifies an approximately 175-mile portion of prehistoric *ala loa*, and other trails on or parallel to the seacoast extending from Upolu Point on the northern tip of Hawaii Island down the west coast of the island around South Point to the east boundary of Hawaii Volcanoes National Park. The Ala Kahakai National Historic Trail combines surviving elements of the *ala loa* with segments of later *alanui aupuni*, which developed on or parallel to traditional routes, *mauka-makai* trails, and more recent pathways and roads that created links between the historic segments. Natural and cultural resources and landscapes are vital to the mission of the Ala Kahakai National Historic Trail.

Ala Kahakai National Historical Trail is aware that Kaloko-Honokohau National Historical Park is commenting on the proposed Kaloko Makai development and echoes the concerns raised by the Park regarding: the impacts on the Honokohau Settlement National Historical Landmark, cultural and natural resources including trails, associated anchialine pools, fishponds, endangered

species, wetlands, and near-shore marine resources. Ala Kahakai NHT is also extremely concerned with how the project will mitigate impacts from surface water drainage, non-point source pollution, water system, wastewater system, roadway system and traffic, noise, air quality, visual resources, and the impacts to coastal and recreational resources.

Archeological and Cultural Resources:

The National Park Service supports the preservation of cultural and natural landscapes, including historic trails, wherever possible. Within the proposed Kaloko Makai development at least two *mauka-makai* trails exist, which historically connected the *mauka* communities with *makai* lands within Kaloko-Honokohau National Historical Park.

According to an abstract completed by the State of Hawaii, Na Ala Hele, Hawaii Trails and Access System (Appendix A), the two trails have been identified as being considered State owned under Chapter 264-1 (b) Hawaii Revised Statutes (HRS), or the Highways Act. The two trails:

1. "Trail to the Sea Coast" a.k.a "Road to the Sea". This trail is referred to as State Site 50-10-27-10714. This trail has been considered eligible for nomination to the State Register of Historic Places under criteria D and E (Title 13, Subtitle 8, Chapter 198 Hawaii Administrative Rules (HAR)).
2. "Trail to Honokohau". This trail passes diagonally through the SE corner of the project area in TMK: 7-3-009:028. is referred to as State Site 50-10-27-18099, in the ahupua'a of Honokohau Nui. This trail has been considered eligible for nomination to the State Register of Historic Places under criteria A, C, and D (Title 13, Subtitle 8, Chapter 198 Hawaii Administrative Rules (HAR)).

Both of these trails lead into Kaloko-Honokohau NHP and are an important piece of the area's history. The Kaloko Makai EISPN acknowledges only the "Road to the Sea" and needs to also recognize and incorporate the "Trail to Honokohau" within project planning and design.

Other trails that predate 1892 will also be identified in the upcoming archaeological inventory survey and should be preserved and incorporated into the planning and design for the project.

Thank you for the opportunity to provide these comments early in your environmental review process. To receive a copy of the Ala Kahakai NHT Comprehensive Management Plan, or if you have questions on these comments, please contact me at 808-326-6012 x101, aric_arakaki@nps.gov, or Rick Gmirkin, Archaeologist at x 102, rick_gmirkin@nps.gov.

Sincerely,

Aric Arakaki
Superintendent

Attachments:
Attachment A: Na Ala Hele regarding Kaloko Makai Development – 08/06/2008

cc: Office of Environmental Quality Control
Stanford Carr Development, LLC
County of Hawaii Planning Department
State Office of Planning
Hawaii Department of Health
State of Hawaii Land Use Commission
State of Hawaii Historic Preservation Division
National Marine Fisheries Service
Office of Hawaiian Affairs
Makani Hou o Kaloko-Honokohau
Na Kokua o Kaloko-Honokohau
National Parks Conservation Association
NPS Pacific West Regional Office

APPENDIX A

COPY

NA ALA HELE
Hawai'i Trail & Access System

August 6, 2008

Ref: H08:17 Kaloko Makai

TO: Clement Chang, Trails Specialist

FROM: Doris Moana Rowland, Abstractor DMR

THROUGH: Curt Cottrell, Program Manager

SUBJECT: Disposition of Trails through proposed Kaloko Makai Development designated as Tax Map Keys: 7-3-9-17, 25, 26 and 28, situate at Kaloko, North Kona, Island of Hawaii

The proposed Kaloko Makai Development Project is a 1,142 acre master planned community in Kaloko, North Kona, owned by Kaloko Properties Corporation and SCD Kaloko Makai LLC. Within the proposed development are located two historic trails considered to be state-owned pursuant to the Highways Act of 1892:

1) Trail to the Sea Coast, and
2) Trail to Honokohau

Both of these trails were identified in an abstract prepared in 2005 in response to the development of lands adjoining Kaloko Makai. This abstract filed as H04:15 Kohanaiki Road, discussed the aforesaid two historic trails crossing through Tax Map Keys: 7-3-9-19 and 32.

Abstract H04:15 Kohanaiki Road is attached in its entirety for your reference. There is no need to duplicate the research completed in 2005 since the history, alignment and status of the trails through Kaloko Makai are the same.

Therefore, it is recommended that a modern metes and bounds survey description of these trails within the proposed Kaloko Makai Devleopment be completed and all adjoining landowners and other interested parties be notified of any future management plans of these historic publicly owned features.

c: Pua Aiu, Historic Preservation

Division of Forestry & Wildlife • Dept. of Land & Natural Resources • 1151 Punchbowl Street, Room 224 • Honolulu, Hawaii 96813

NA ALA HELE
Hawai'i Trail & Access System

February 25, 2005

Ref: H04:15 Kohanaiki Road

TO: Irving Kawashima, Trails Specialist

FROM: Doris Moana Rowland, Abstractor DMR

THROUGH: Curt Cottrell, Program Manager CAC

SUBJECT: Disposition of Trails and Old Roads within the Y-O Project through Kohanaiki and Kaloko affecting Tax Map Keys: 7-3-9:19 and 32

The Y-O Project encompasses approximately 408 acres and is comprised of Tax Map Keys: 7-3-9:19 and 32 being portions of Grant 2942 issued to Hulikoa in 1863 and Royal Patent 8214, Land Commission Award 7715, Apana 11 issued to Lota Kamehameha in 1845. Grant 2942 lies entirely within the ahupuaa of Kohanaiki and Land Commission Award 7715:11 is situate within Kaloko. A reduced copy of the current tax map is included for easy reference.

The Y-O Limited Partnership conveyed its interest in parcels 19 and 32 (besides other lands) to Koloko Heights Associates, LLC, on November 30, 2004. This Limited Warranty Deed is filed in the Bureau of Conveyances as Document Number 2004-244541. For the purposes of this report the land will continue to be referred to as the Y-O Project.

Record research was conducted to establish the existence of trails and roadways prior to 1892 as identified in documents, maps, descriptions, and sketches. Government surveyor Joseph S. Emerson identified several trails that run in a mauka-makai direction through the subject parcels: Trail to Honokohau, Trail to Sea Coast, Road to Na Wahi Ahu and Kohanaiki Road. The following field notes and survey maps provide information about the location of each of these trails.

Trail to Honokohau and Trail to Sea Coast

Emerson compiled Registered Map Number 1280 titled "Kailua Section, North Kona," from data collected in 1882 and recorded in Field Book Number 253. On June 4, 1882, a sketch of the view up the slope of Hualalai on Page 69 (**Exhibit A**) of the field book is of importance as it delineates a portion of two trails to the sea coast from Kohanaiki mauka identified as "Trail to Honokohau" and "Trail to Sea Coast".

Both trails originate in the vicinity of Kohanaiki Village and connect to the mauka Government Road. The entire alignment of these trails is not depicted on this sketch, however Registered Map Number 1280 provides a complete view of the alignments. This portion of Registered Map Number 1280 has been reproduced and is attached as **Exhibit B**.

Registered Map Number 1280 delineates the two trails forking near Kohanaiki Church with one trail passing through a portion of Grant 2942 and terminating at the Kaloko Fishpond. This is most likely the trail identified in Field Book 253:69 as "Trail to Sea Coast." The second trail shown on Registered Map Number 1280 begins near Kohanaiki Church and goes makai through Kaloko and Honokohau with the terminus on the shoreline near the Aimakapaa Fishpond. This is probably the trail labeled "Trail to Honokohau" in Field Book 253:69.

Using an Auto CAD overlay of the current tax map (shown in red) and Registered Map Number 1280 (shown in green) it is possible to identify the two trails passing through portions of the Y-O Project lands (**Exhibit C**).

Road to Na Wahi Ahu

In September of 1888, Emerson prepared a map titled "Akahipuu Section, North Kona, Hawaii" on file at the State Survey Office as Registered Map Number 1449. The map shows a segment of trail running in a mauka-makai direction from the Triangulation Station labeled "Na wahi ahu" on the boundary of Kohanaiki within Grant 2942 and abruptly terminating just past Triangulation Station "Kumuohe" in Kaloko. (**Exhibit D**) Field Book 292:57-58 identifies this trail within the Kohanaiki Houselots as "Road to Na Wahi Ahu." (**Exhibit E**) This label indicates the trail was much longer than as shown on Exhibit D.

Kohanaiki Road

In 1889 Emerson prepared another map of the Akahipuu Section filed at the State Survey Office as Registered Map Number 1512. A reduced copy of this map is attached as **Exhibit F**. On this map Emerson identifies the trail

previously referred to as "Road to Na Wahi Ahu" as "Kohanaiki Road." This alignment is totally within Kohanaiki and may be the road noted in Field Book 291:71–72 as "…. a very straight road leading from Kohanaiki to the sea."

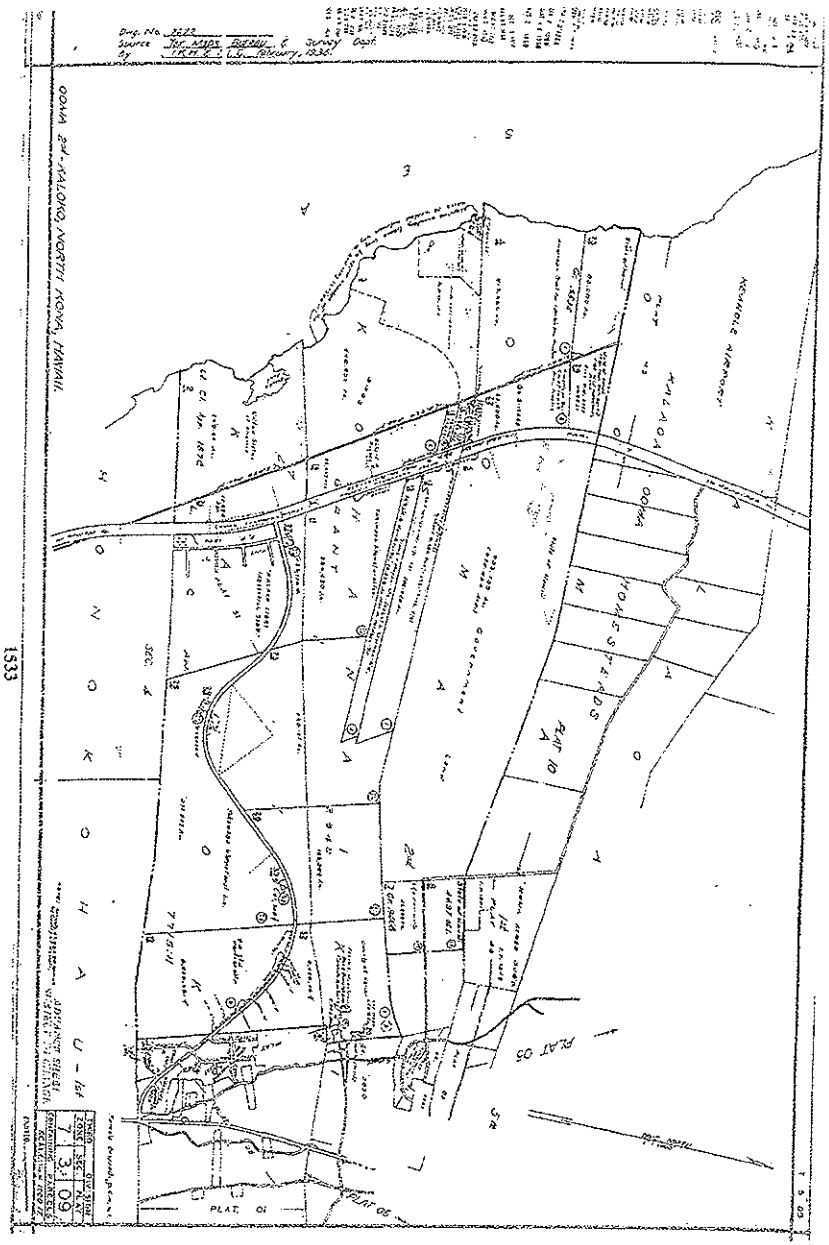
It is not clear if the Road to Na Wahi Ahu and Kohanaiki Road is the same feature because the map data is inconclusive. Registered Map Number 1449 suggests the Road to Na Wahi Ahu terminated on the boundary of Kaloko without providing access to the shoreline and the Lower Government Road. Similarly Registered Map Number 1512 does not illustrate if Kohanaiki Road continued to the sea.

Conclusion

The numerous land grants and Land Commission Awards within Kohanaiki and Kaloko indicate the presence of many residents who would require pedestrian access from the uplands to the coastline and adjoining ahupuaa. It is not known if any portions of these trails are discernable on the ground today or if they have evolved into vehicular access routes.

Based on the available evidence pursuant to the Highways Act of 1892, the State of Hawaii through its Board of Land and Natural Resources may claim a fee simple interest in the trails and roads described in this report. It is recommended that a modern metes and bounds survey description of these trails be completed and all adjoining landowners be notified of any future management plans of these historic publicly owned features.

c: Melissa Chinen, Historic Preservation
Peter Young, Chairman



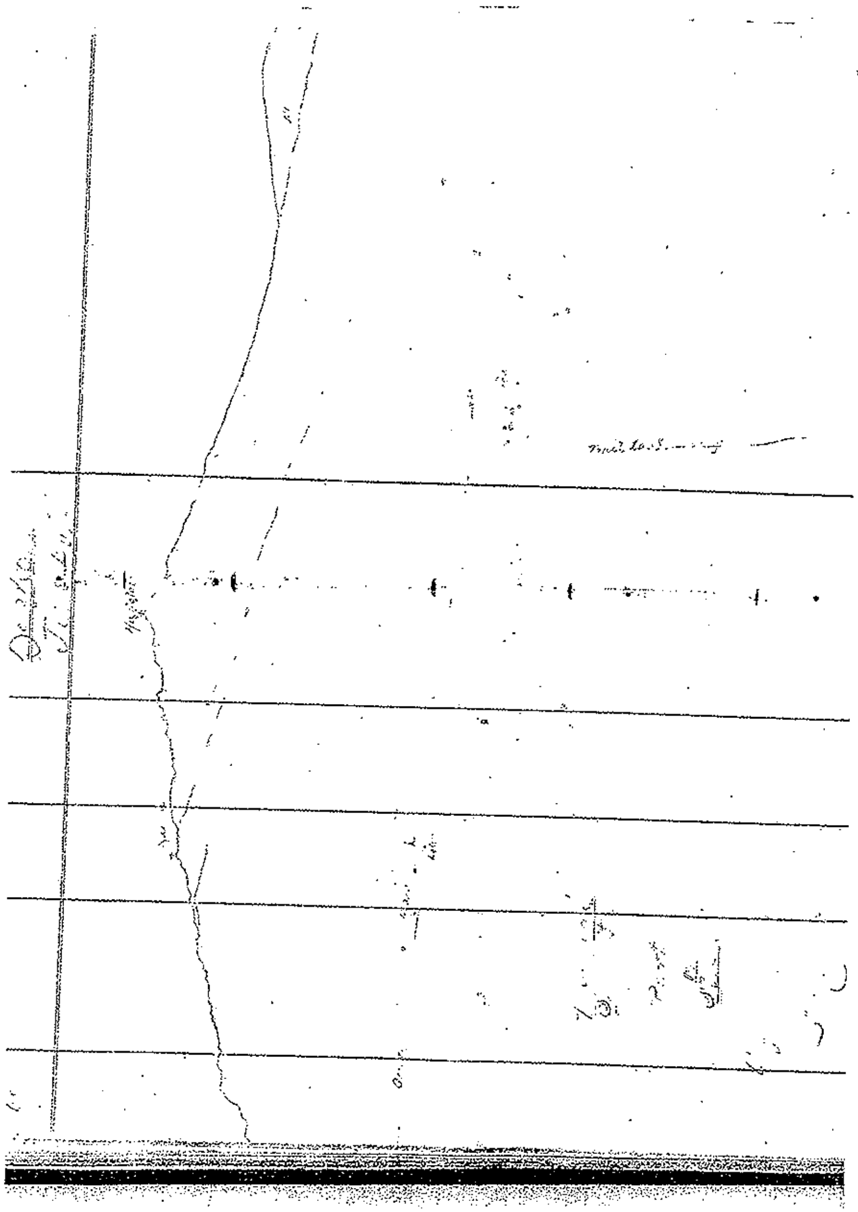


EXHIBIT A

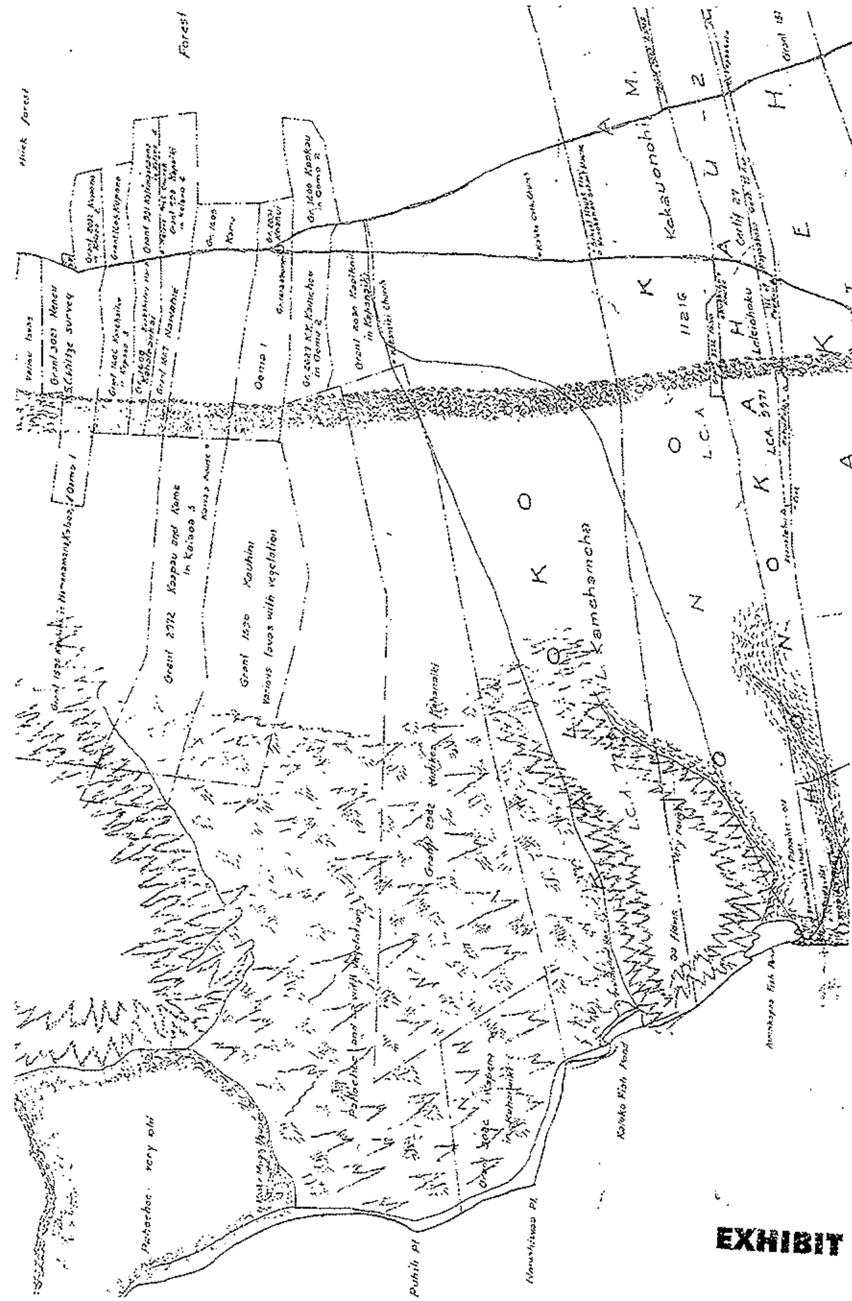


EXHIBIT B

EXHIBIT D

EXHIBIT C

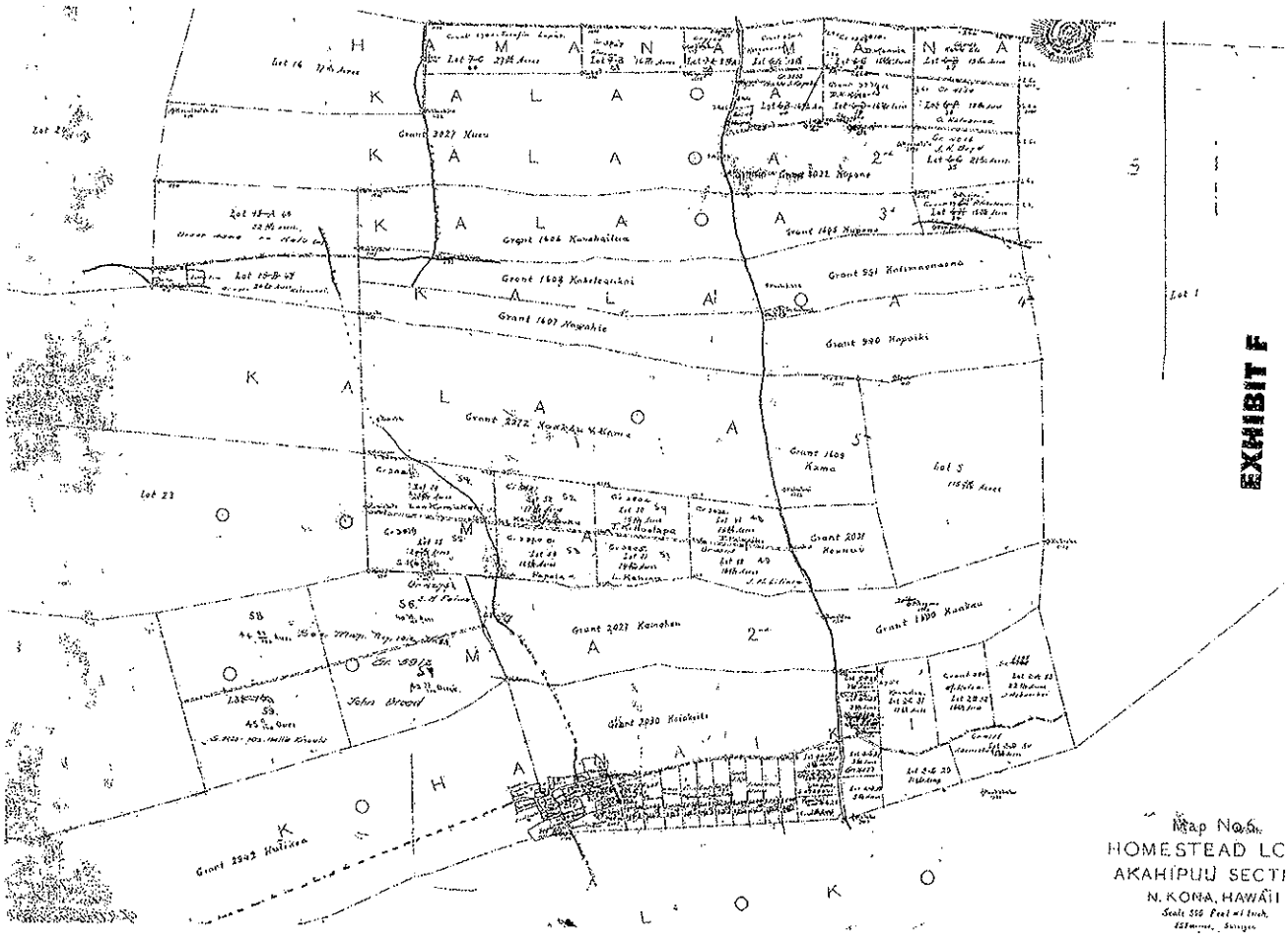


EXHIBIT F

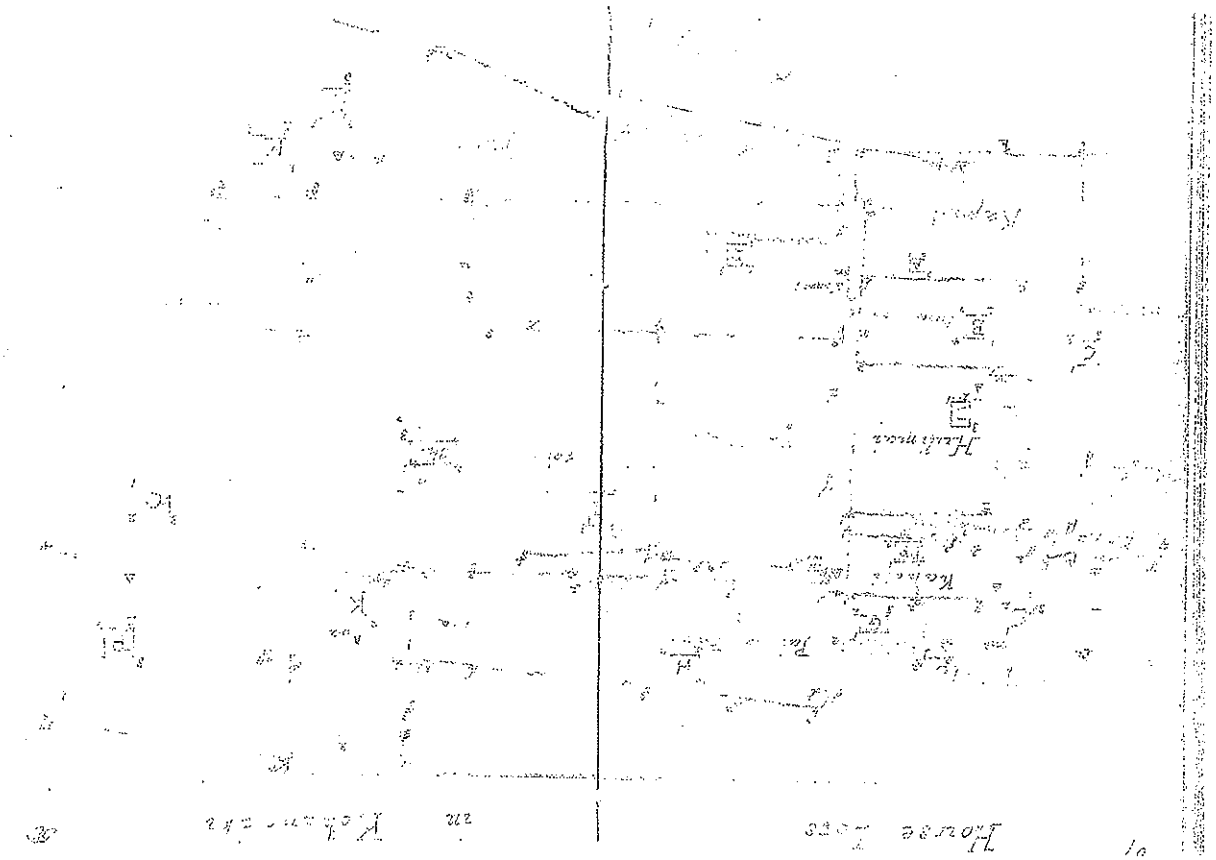


EXHIBIT E

WILSON OKAMOTO
CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS

1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Aric Arakaki, Superintendent
U.S. National Park Service
Ala Kahakai National Historic Trail
73-4786 Kanalani Street, Suite 14
Kailua-Kona, HI 96740

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Arakaki:

Thank you for your letter dated October 22, 2010 (L7621). We offer the following responses in the respective order of your comments:

1. We acknowledge your shared concerns with Kaloko-Honokohau National Historic Park, National Park Service, regarding the potential impacts on the landmark, cultural and natural resources, and coastal resources. The Draft EIS will include discussions on impacts from surface water drainage, non-point source pollution, water system, wastewater system, traffic, noise, air, etc. and impacts to coastal and recreational resources. Relevant studies are being prepared and will be included in the Draft EIS.

2. The Draft EIS will incorporate the information you provided on the Kohanaiki Trail (Road to the Sea) and the Honokohau Trail (it is of note that the Honokohau trail is not located on the subject property). We would like to continue to work with you in preserving these trails.

The Draft EIS will discuss the historic trails that traverse through the project site.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR
THEODORE E. LIU
DIRECTOR
ABBEY SETH MAYER
DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone (808) 587-2846
Fax (808) 587-2824

EM

Ref. No. P-13158

November 3, 2010

NOV 04 2010

Mr. Earl Matsukawa, AICP, Project Manager
Wilson Okamoto Corporation
1907 S. Beretania Street, Suite 400
Honolulu, Hawai'i 96826

Dear Mr. Matsukawa:

Subject: LUC Docket A07-778, SCD Kaloko Makai, LLC
Kaloko Makai
Environmental Impact Statement Preparation Notice
TMK(s) (3) 7-3-009: 017, 025, 026, 028, 063, and 064
Kaloko and Kohanaiki, North Kona, Island of Hawai'i

The Office of Planning (OP) appreciates the opportunity to comment on the Environmental Impact Statement Preparation Notice (EISPN) for the above referenced proposal, for which the landowner has filed a petition to reclassify approximately 952.165 acres of land from the State Agricultural and Conservation Districts to the State Urban District. The petitioner proposes to develop a master-planned community on approximately 1,142.165 acres of land at Kaloko and Kohanaiki.

The Office of Planning will be coordinating the State's position on the petition with respect to areas of cross-cutting State concern. It is very important that the Draft Environmental Impact Statement (DEIS) fully identify and discuss potential impacts, including cumulative and secondary impacts of the proposed project, as well as recommendations for mitigating potential adverse impacts on the following areas of State concern.

1. **Groundwater and Surface Water Resources.** Water resource protection and water quality are critical State issues. The DEIS should discuss the water requirements of the proposed project and identify the proposed potable and non-potable water sources to be used for the project, as well as measures proposed to reduce water demand and promote water reuse in the project. This discussion should identify whether the proposed project is within a designated Water Management Area, the impact of the project on the sustainable yield of affected aquifers, and the impact of the project on projected water use and system improvements contained in the County's water use and development plan. The

DEIS should also discuss the cumulative impacts of planned development in this region on the proposed drinking water source.

As noted in the EISPN, groundwater withdrawal and potential recharge to the underlying groundwater resource from stormwater runoff, drainage, and wastewater effluent are of critical concern to the Kaloko-Honokōhau National Historical Park makai of the project area. The DEIS should discuss potential impacts on the Park's natural and cultural resources and how these impacts will be mitigated.

2. **Agricultural Lands.** The DEIS should identify the extent of existing agricultural activity in the vicinity of the project area, and discuss what impact the proposed development might have on any agricultural activity in the area.

3. **Cultural, Archaeological, and Historic Resources.** The DEIS should include a complete inventory of archaeological and historic sites found on the subject property, and identify the status of any monitoring and preservation plans being prepared for or approved by the State Historic Preservation Division. The DEIS should identify and describe any cultural resources and cultural practices, including visual landmarks, if applicable, on the subject property and within the ahupua'a in which the property is situated. The DEIS should discuss the impact of the proposed project on identified cultural resources and practices, alternatives considered, and proposed mitigation measures.

   OP recommends the DEIS include a map that overlays the Conceptual Land Use Map with identified sites and resources to enable the reviewer to visualize the relationship between proposed development and existing resources to be preserved and protected.

4. **Coastal Zone Management (CZM) Concerns.** The State oversees protection of natural, cultural, and economic resources within the coastal zone, which is defined as all lands of the State and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the United States territorial sea (§205A-1, Hawai'i Revised Statutes). The DEIS should note this definition of the coastal zone, and discuss how the proposed project will balance the competing values of economic development and preservation of coastal resources, including the following CZM objective areas:

   a. **Coastal and Ocean Resources.** The State has an affirmative duty to protect Hawai'i's nearshore waters. The DEIS should discuss important coastal and marine resources and ecosystems that may be impacted by the proposed project. The DEIS should discuss how wastewater and

stormwater generated by the project will be prevented from adversely impacting nearshore waters, species, and habitats.

The DEIS should discuss the impact of the project on existing site and offsite hydrology, and how the project will manage stormwater and runoff. OP recommends the use of green infrastructure, specifically the use of low impact development design and other best management practices (BMPs) that promote onsite infiltration and minimize runoff from storm events. More information on stormwater BMPs can be found at http://hawaii.gov/dbedt/czm/initiative/lid.php.

b. **Coastal and Other Hazards.** The DEIS should describe any hazard conditions that are relevant to the site, such as potential risk or harm from hurricane, wind, flooding from mauka areas, erosion, volcanic activity, earthquake, landslide, subsidence, and point and nonpoint source pollution. The DEIS should describe the measures that are proposed to mitigate any hazard impacts, and provide an update on the County's adoption of the International Building Code.

The DEIS should also include a discussion of whether wildfire hazard is a concern in the area and possible mitigation measures that might be required to address any potential threat from wildfires.

c. **Coastal Scenic Resources.** The DEIS should discuss the project's impact on scenic views to and from the coast and how these will be mitigated.

5. **Affordable Housing.** Increasing the supply of affordable housing is a critical State and County issue. The DEIS should specifically discuss how the Petitioner plans to meet the County affordable housing and workforce housing requirements, to include a discussion of how the project's proposed residential product types will be allocated among the market and various affordable housing target populations, and the expected price ranges for the different product types.

6. **Impact on State Facilities.** The DEIS should include a discussion of anticipated short- and long-term project impacts on State-funded facilities, including schools, highways, harbors, and airports, and document State agency concerns related to their respective State facilities and resources. The DEIS should cite the measures proposed to mitigate the project's impacts on State facilities and describe discussions held with State agencies to address their concerns.

7. **Energy Use and Impacts.** The DEIS should quantify the projected energy requirements of the project by type of use, and discuss measures to be taken to

reduce energy demand, promote energy efficiency, and to promote use of alternative, renewable energy sources, and otherwise advance State efforts to increase energy efficiency and alternative energy use under the Hawai'i Clean Energy Initiative. OP recommends the project's energy and resource use be evaluated with respect to the U.S. Green Building Council's (U.S. GBC) Leadership in Energy and Environmental Design (LEED) rating systems for new construction and neighborhood development. The DEIS should also identify any generating or transmission capacity constraints that may arise as a result of the proposed project and other projects planned for the region. The DEIS should also discuss the degree to which the project promotes transportation energy savings and reduces vehicular trips for project residents and users within the project and the region.

8. **Biota.** The DEIS should include an inventory of flora and fauna, including invertebrates, found on or in proximity to the project site and in any lava tubes and caves on the property. Flora and fauna of concern should not be limited to listed threatened or endangered species or those under consideration for listing. The applicant should also consult with the Database Manager at the Hawai'i Biodiversity and Mapping Program, Center for Conservation Research and Training, University of Hawai'i, (808) 956-8094, as to the potential for the presence of rare species in the project area. The DEIS should also discuss measures to be taken to protect rare, threatened or endangered species, or ecosystems of concern. Consideration should be given to conducting field observations in both wet and dry season surveys to capture the fullest range of flora and fauna.

The DEIS should provide an update on the delineation of the native dryland forest boundary and discuss specific recommendations made by the U.S. Fish and Wildlife Service and the Department of Land and Natural Resources for management of the dryland forest preservation area, including management of feral goats and pigs, if they are found in the updated biological surveys.

9. **Conformance with County Plan Designations and Urban Growth or Rural Community Boundaries.** Act 26, Session Laws of Hawaii 2008, reaffirmed the Land Use Commission's (LUC) duty to consider any proposed reclassification with respect to the Counties' adopted general, community, or development plans. Thus, the DEIS should discuss the proposed project's consistency with the County land use plans, including the following:

a. **Siting of regional hospital.** The DEIS should include a discussion of public and private efforts related to the siting of a new regional hospital in Kona, and any preliminary recommendations of these efforts. This will

assist the reader in better understanding whether the project site is the most suitable location for a regional hospital.

b. **Transportation concurrency.** The DEIS should identify any transportation improvements that may be required by the Kona Community Development Plan, prior to occupancy of units or development within the project area.

c. **Ane Keohokalole Highway.** The DEIS should discuss how the project intends to reconcile the creation and maintenance of a walkable, pedestrian-friendly village center with the mid-level road's function as a major, limited access arterial, when the planned arterial bisects the village center.

10. **Sustainability Analysis.** The adoption of sustainable building and development practices has long-term environmental, social, and economic benefits to Hawai'i's residents and communities. The EIS process is extremely valuable as a means to identify and discuss the specific sustainable design and development practices, including green building practices, which will be incorporated in the proposed project. The Office of Environmental Quality Control's, *Guidelines for Sustainable Building Design in Hawai'i*, and the U.S. GBC's LEED programs for new construction and its pilot program for neighborhood development (LEED-ND) offer guidelines and checklists for this purpose.

The LEED-ND rating system, in particular, is especially useful in profiling how a project protects and enhances the overall health, natural environment, and quality of life of communities. The rating system provides a range of development features and strategies that promote efficient water, energy, and resource use, including waste reduction, as well as location and design elements to reduce transportation impacts.

OP recommends that the DEIS includes an analysis of the project with respect to the LEED-ND system, and provide a discussion of the LEED elements that will or could be incorporated into the project. This information would greatly aid agencies, decision-makers, and the public in reviewing the project application.

11. **Wastewater Treatment and Disposal.** The DEIS needs to identify the proposed means of wastewater treatment and disposal, including the reuse and/or disposal of treated effluent and the disposal of waste solids, and the potential impacts and mitigation measures associated with the selected method of treatment and disposal. In addition, the DEIS should discuss how the project will implement

Policy PUB-4.6, Wastewater Reuse Area, of the Kona Community Development Plan.

12. **Solid Waste Management.** The DEIS should quantify the volume of solid waste likely to be generated by the project, and describe the impact the project will have on the County's existing and planned capacity for managing solid waste as represented in the County's solid waste management plan. The DEIS should discuss specific mitigation measures to be taken to reduce solid waste generation and to ensure that recycling and reuse are incorporated within the project area. Please also clarify what "waste diversion and reduction facilities" refers to on page 3-28 of the EISPN.

13. **Environmental Health Hazard.** If the project will have a potential to generate hazardous materials or result in the possible contamination of the air, soil, or water, please discuss how environmental and public health and safety will be protected, in particular, measures to be taken in areas planned for industrial use.

The DEIS should identify and discuss any potential health and environmental threats that may be present due to contamination from past or current use of the site, including findings from Phase I or Phase II environmental site assessments conducted at the project site. OP recommends that an ASTM 1527-05 Phase I Environmental Site Assessment or equivalent be conducted for the Master Plan area, if one has not already been conducted.

14. **Development Timetable.** The EISPN anticipates three phases of development, with major infrastructure completed by 2025. LUC requires that projects seeking reclassification be substantially completed within ten years or seek incremental approvals. The DEIS should reference LUC rules (Section 15-15-50, Hawai'i Administrative Rules) and provide a schedule of development for each phase of the total project and a map showing the location and timing of each phase or increment of development. This development schedule will be critical for the review of the petition for the proposed district boundary amendment.

15. **Miscellaneous Comments**

a. **Section 2.2, Project Need.** This section should provide a substantive discussion of the need for the proposed project in the context of other planned development in the region.

b. **Section 6, Alternatives to the Proposed Action.** This section needs to evaluate distinct alternatives to the proposed action, such as a smaller

footprint for the proposed new community and the potential for siting the proposed development package in another location/s on the Island.

c. **Section 6.1, No Action Alternative.** This discussion should be clarified: the no action alternative has no impact on existing tax revenues and does not reduce them. Similarly, the number of housing units and jobs are not reduced, although the opportunities for increasing housing and jobs are foregone under this alternative.

d. The list of permits/approvals should include those approvals required from the State Department of Health for new private wastewater treatment plants and possibly injection wells, should the private wastewater treatment system be pursued.

OP looks forward to receiving the DEIS with the potential impacts and mitigation measures for the above issues addressed. If you have any questions, please call Ruby Edwards of the Land Use Division at 587-2817.

Sincerely,

Abbey Seth Mayer
Director

c: Mr. Orlando Davidson, LUC

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7469-01
July 25, 2011

Ms. Mary Lou Kobayashi, Planning Program Administrator
Office of Planning
Department of Business, Economic Development and Tourism
State of Hawaii
P.O. Box 2359
Honolulu, HI 96804-2359

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Ms. Kobayashi:

Thank you for your letter dated November 3, 2010 (P-13158). We offer the following responses in the respective order of your comments:

1. Groundwater and Surface Water Resources: Kaloko Makai's water demand will require development of additional water sources, storage and transmission facilities. Kaloko Makai is investigating several alternatives to address its potable water needs. The Draft EIS will discuss the proposed project's demands, alternative water sources and the potential impact to ground water resources and the nearshore marine environment associated with the development of the alternative sources.

   The Draft EIS will also discuss water conservation to be achieved through the use of reclaimed wastewater.

2. Agricultural Lands: According to the ALISH, approximately 6 percent of the Petition Area is designated "other" and the remainder is not classified. Kaloko Makai will not have an impact on agriculturally significant lands. A discussion and maps on ALISH and LSB ratings and designations for the project site will be included in the Draft EIS.

3. Cultural, Archaeological, and Historic Resources: An Archaeological Inventory Survey and a Cultural Impact Assessment have been prepared for the project and will be summarized in the forthcoming Draft EIS. A graphic displaying sites and resources identified by these studies overlaid on the conceptual land use plan will be provided.

   The proposed project will comply with State and County laws and rules regarding the preservation or archaeological resources and historic sites. The archaeological inventory survey is presently under review by SHPD.

4. Coastal Zone Management: The Draft EIS will include a discussion on Coastal Zone Management and how the project conforms to the project.

   A discussion of potential impacts on coastal and ocean resources; coastal and other hazards; and coastal scenic resources will also be included.

5. Affordable Housing: Kaloko Makai is a master-planned community offering a wide range of housing types and affordability. Kaloko Makai will meet affordable housing requirements established by Chapter 11, Hawaii County Code Affordable Housing Ordinance, as well as applicable provisions of the Kona Community Development Plan.

6. Impact on State Facilities: The Draft EIS will include discussions of the proposed project's impacts on State facilities.

7. Energy Use and Impacts: Kaloko Makai will implement feasible measures to promote energy conservation and environmental stewardship, such as the standards and guidelines promulgated by the US Green Building Council, US EPA Energy Star Program, and other similar programs.

8. Biota: Flora and fauna surveys have been conducted and the respective reports will be summarized and included in the Draft EIS. Potential impacts and mitigation measures will be discussed.

   Kaloko Makai has been working with the US Fish & Wildlife Service and the Department of Land and Natural Resources on the delineation and preservation of the 150 acre native dryland forest. Kaloko Makai has determined that the project may cause the taking of two listed plant species (`aiea and hala pepe) and one candidate species (ko`oko`olau). In response to this, Kaloko Makai prepared a Habitat Conservation Plan (HCP) to address the short- and long-term management measures to protect these species.

9. Conformance with County Land Use: The Draft EIS will include a discussion on how the Kaloko Makai conforms with County land use plans, including the Kona Community Development Plan (CDP).

10. Sustainability Analysis: In the design and construction of Kaloko Makai, SCD – TSA Kaloko Makai, LLC will seek to implement feasible measures to conform to the Office of Environmental Quality Control's (OEQC) Building Design Guidelines and Leadership in Energy and Environmental Design (LEED) program.

11. Wastewater Treatment and Disposal: In the event connection to a public wastewater system is not available, Kaloko Makai will construct and operate a Private Wastewater Treatment Plant (WWTP) within the project. The Kaloko Makai facility will treat the wastewater to produce reclaimed (R-1) quality water for general irrigation within Kaloko Makai, thus lessening demand for potable water. Most of the project site is located within the Kona CDP Wastewater Reuse Area (Policy PUB 4.6). The Draft EIS will discuss potential impacts and mitigation measures associated with the method chosen.

12. Solid Waste Management: The Draft EIS will discuss potential impacts and mitigation measures associated with solid waste generation.

13. Environmental Health Hazard: Kaloko Makai is not expected to generate hazardous materials or result in the possible contamination of the air, soil, or water. Impacts on the quality of air, soil and water would be related to construction of the project. The proper mitigation measures will be undertaken.

    No prior uses of the project site suggestive of the need to prepare a Phase 1 environmental site assessment.

14. Development Timetable: A phasing plan will be included in the Draft EIS.

15. Miscellaneous Comments: An expanded discussion on project need, alternatives to proposed action, and list of permits/approvals will be included in the Draft EIS.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

EM

RECEIVED
OCT 25 2010
WILSON OKAMOTO CORPORATION

October 21, 2010

Wilson Okamoto Corporation
1907 South Beretania Street Suite 400
Honolulu, Hawaii 96826

Attention: Mr. Earl Matsukawa, AICP, Project Manager

Ladies and Gentlemen:

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN) for Kaloko Makai

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR), Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comment.

Other than the comments from Division of State Parks, Division of Forestry & Wildlife, Land Division-Hawaii District, Engineering Division, the Department of Land and Natural Resources has no other comments to offer on the subject matter. Historic Preservation will be submitting comments through a separate letter. Should you have any questions, please feel free to call our office at 587-0414. Thank you.

Sincerely,

Russell Y. Tsuji
Administrator

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 21, 2010

MEMORANDUM

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Hawaii District

FROM: Charlene Unoki, Assistant Administrator
SUBJECT: Environmental Assessment (EA)/Environmental Imapct Statement preparation Notice (EISPN)
LOCATION: Island of Hawaii
APPLICANT: Wilson Okamoto Corporation on behalf of SCD-TSA Kaloko Makai, LLC

Transmitted for your review and comment on the above referenced document. If you already received the document from Wilson Okamoto, we would appreciate your comments be submit by October 20, 2010.

Only 1 copy of the report available in Room 220.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

RECEIVED
LAND DIVISION
2010 SEP 30 A8:45
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

Attachments

( ) We have no objections.
( ) We have no comments.
(X) Comments are attached.

Signed:
Date: 9/29/10

DEPARTMENT OF LAND AND NATURAL RESOURCES
ENGINEERING DIVISION

LM/CharleneUnoki
REF.:EISPNKalokoMakai
Hawaii.488

COMMENTS

(X) **We confirm that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Zone X. The Flood Insurance Program does not have any regulations for developments within Zone X.**

( ) Please take note that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Zone____.

( ) Please note that the correct Flood Zone Designation for the project site according to the Flood Insurance Rate Map (FIRM) is ___.

( ) Please note that the project must comply with the rules and regulations of the National Flood Insurance Program (NFIP) presented in Title 44 of the Code of Federal Regulations (44CFR), whenever development within a Special Flood Hazard Area is undertaken. If there are any questions, please contact the State NFIP Coordinator, Ms. Carol Tyau-Beam, of the Department of Land and Natural Resources, Engineering Division at (808) 587-0267.

Please be advised that 44CFR indicates the minimum standards set forth by the NFIP. Your Community's local flood ordinance may prove to be more restrictive and thus take precedence over the minimum NFIP standards. If there are questions regarding the local flood ordinances, please contact the applicable County NFIP Coordinators below:

( ) Mr. Robert Sumitomo at (808) 768-8097 or Mr. Mario Siu Li at (808) 768-8098 of the City and County of Honolulu, Department of Planning and Permitting..

( ) Mr. Carter Romero at (808) 961-8943 of the County of Hawaii, Department of Public Works.

( ) Mr. Francis Cerizo at (808) 270-7771 of the County of Maui, Department of Planning.

( ) Ms. Wynne Ushigome at (808) 241-4890 of the County of Kauai, Department of Public Works.

( ) The applicant should include water demands and infrastructure required to meet project needs. Please note that projects within State lands requiring water service from the Honolulu Board of Water Supply system will be required to pay a resource development charge, in addition to Water Facilities Charges for transmission and daily storage.

( ) The applicant should provide the water demands and calculations to the Engineering Division so it can be included in the State Water Projects Plan Update

(X) Additional Comments: Please correct information on page 3-9, Item 3-6, Flood Hazard. The correct Community Panel Numbers are 1551660684C and 1551660703C (Panels not Printed). Copies attached.

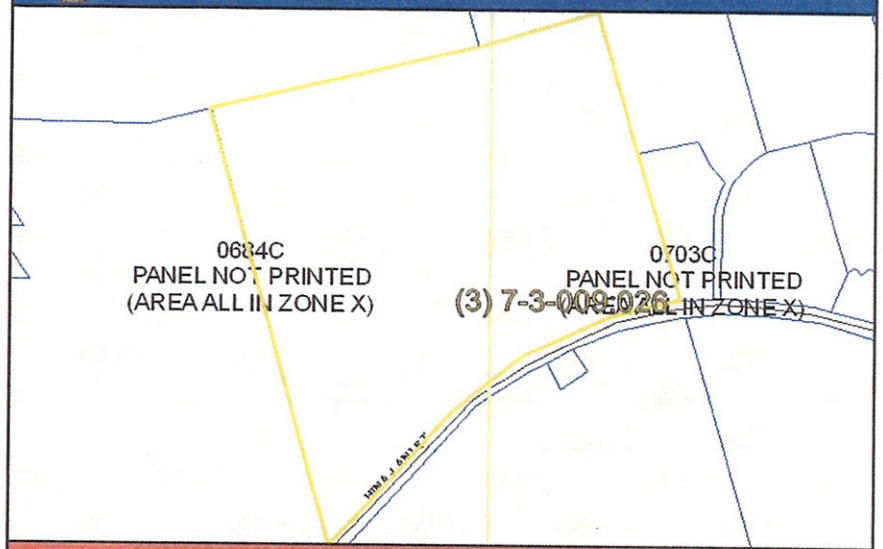
( ) Other: _____

Should you have any questions, please call Ms. Suzie S. Agraan of the Planning Branch at 587-0258.

Signed: _____
CARTY S. CHANG, CHIEF ENGINEER

Date: 9/29/10

State of Hawaii
FLOOD HAZARD ASSESSMENT REPORT



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD ZONE DEFINITIONS

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD – The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water-surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

- **Zone A:** No BFE determined.
- **Zone AE:** BFE determined.
- **Zone AH:** Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
- **Zone AO:** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
- **Zone V:** Coastal flood zone with velocity hazard (wave action); no BFE determined.
- **Zone VE:** Coastal flood zone with velocity hazard (wave action); BFE determined.
- **Zone AEF:** Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

NON-SPECIAL FLOOD HAZARD AREA – An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

- **Zone XS (X shaded):** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- **Zone X:** Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

- **Zone D:** Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

PROPERTY INFORMATION

COUNTY:	HAWAII
TMK NO:	(3) 7-3-009-026
PARCEL ADDRESS:	HINA LANI STREET
FIRM INDEX DATE:	APRIL 02, 2004
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL(S):	1551660703C - PANEL NOT PRINTED
	1551660684C - PANEL NOT PRINTED

PARCEL DATA FROM:	DECEMBER 2009
IMAGERY DATA FROM:	MAY 2005

IMPORTANT PHONE NUMBERS

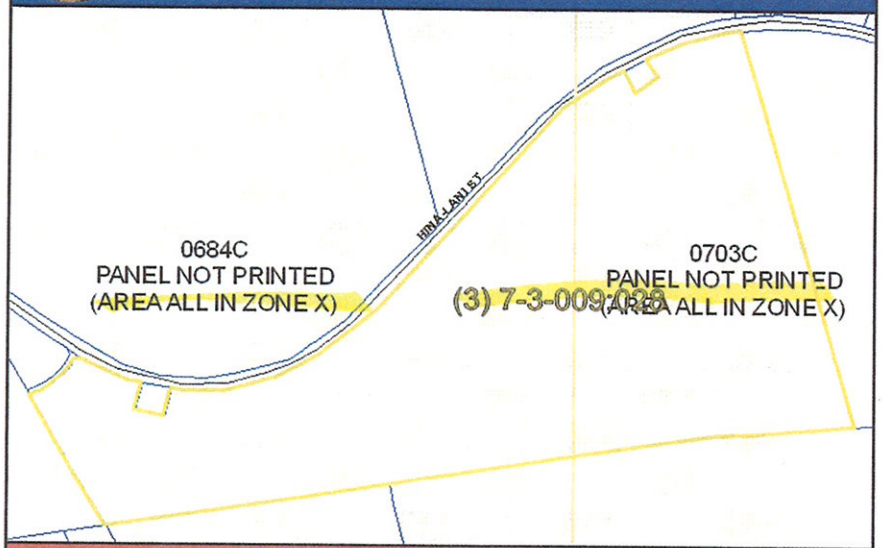
County NFIP Coordinator	
County of Hawaii	
Frank DeMarco, P.E., CFM	(808) 961-8042
State NFIP Coordinator	
Carol Tyau-Beam	(808) 587-0267

Disclaimer: The Department of Land and Natural Resources assumes no responsibility arising from the use of the information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the Department of Land and Natural Resources from any liability, which may arise from its use.

Preliminary DFIRM Disclaimer: If this map has been identified as "PRELIMINARY", please note that it is being provided for commenting purposes only and is not to be use for official/legal decisions or regulatory compliance.

State of Hawaii

FLOOD HAZARD ASSESSMENT REPORT



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD ZONE DEFINITIONS

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD – The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water-surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

- **Zone A:** No BFE determined.
- **Zone AE:** BFE determined.
- **Zone AH:** Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
- **Zone AO:** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
- **Zone V:** Coastal flood zone with velocity hazard (wave action); no BFE determined.
- **Zone VE:** Coastal flood zone with velocity hazard (wave action); BFE determined.
- **Zone AEF:** Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

NON-SPECIAL FLOOD HAZARD AREA – An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

- **Zone XS (X shaded):** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- **Zone X:** Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

- **Zone D:** Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

PROPERTY INFORMATION

COUNTY:	HAWAII
TMK NO:	(3) 7-3-009-028
PARCEL ADDRESS:	HINA LANI STREET
FIRM INDEX DATE:	APRIL 02, 2004
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL(S):	1551660703C - PANEL NOT PRINTED 1551660684C - PANEL NOT PRINTED
PARCEL DATA FROM:	DECEMBER 2009
IMAGERY DATA FROM:	MAY 2005

IMPORTANT PHONE NUMBERS

County NFIP Coordinator
County of Hawaii
Frank DeMarco, P.E., CFM (808) 961-8042
State NFIP Coordinator
Carol Tyau-Beam (808) 587-0267

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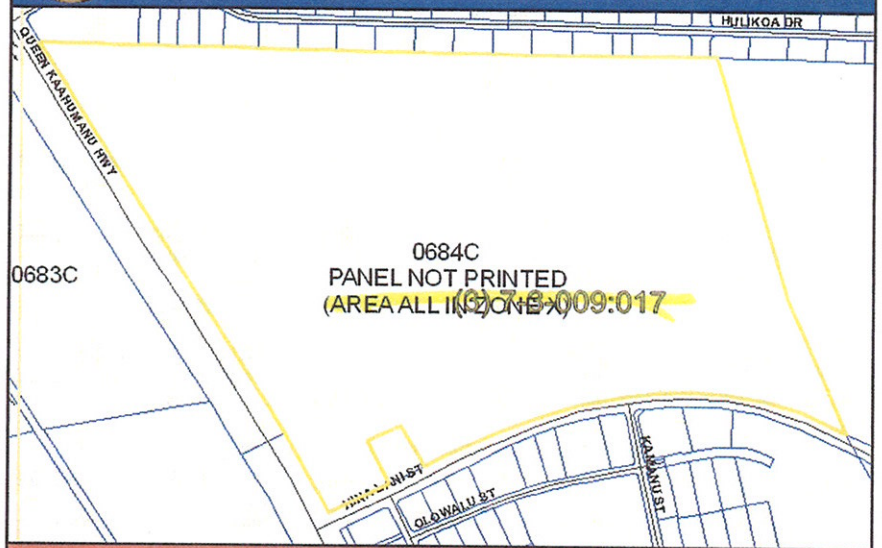
State of Hawaii

FLOOD HAZARD ASSESSMENT REPORT



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD ZONE DEFINITIONS

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD – The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water-surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

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- **Zone AEF:** Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

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- **Zone XS (X shaded):** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- **Zone X:** Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

- **Zone D:** Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

PROPERTY INFORMATION

COUNTY:	HAWAII
TMK NO:	(3) 7-3-009-017
PARCEL ADDRESS:	QUEEN KAAHUMANU HIGHWAY
FIRM INDEX DATE:	APRIL 02, 2004
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL(S):	1551660684C
PANEL EFFECTIVE DATE:	PANEL NOT PRINTED
PARCEL DATA FROM:	DECEMBER 2009
IMAGERY DATA FROM:	MAY 2005

IMPORTANT PHONE NUMBERS

County NFIP Coordinator
County of Hawaii
Frank DeMarco, P.E., CFM (808) 961-8042
State NFIP Coordinator
Carol Tyau-Beam (808) 587-0267

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54319

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RECEIVED
STATE PARKS DIV

'10 SEP 22 A9:33

DEPT OF LAND &
NATURAL RESOURCES

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 21, 2010

MEMORANDUM

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Hawaii District

RECEIVED
LAND DIVISION
2010 SEP 29 A 11:23
DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

FROM: Charlene Unoki, Assistant Administrator
SUBJECT: Environmental Assessment (EA)/Environmental Imapct Statement preparation Notice (EISPN)
LOCATION: Island of Hawaii
APPLICANT: Wilson Okamoto Corporation on behalf of SCD-TSA Kaloko Makai, LLC

Transmitted for your review and comment on the above referenced document. If you already received the document from Wilson Okamoto, we would appreciate your comments be submit by October 20, 2010.

Only 1 copy of the report available in Room 220.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed:
Date: 9/28/10

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 21, 2010

RECEIVED
LAND DIVISION
2010 OCT -4 P 3:28
DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

MEMORANDUM

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Hawaii District

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Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed: for BC
Date: 9/23/10

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 21, 2010

RECEIVED
LAND DIVISION
2010 OCT -4 A 10: 29
DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

MEMORANDUM

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Hawaii District

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Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed: _____
Date: 10·1·10

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Russell Y. Tsuji, Administrator
Land Division
Department of Land and Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, HI 96809

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Tsuji:

Thank you for your letter dated October 21, 2010. We offer the following responses in the respective order of your comments:

Engineering Division

1. We acknowledge the project site is located in Zone X.
2. The Community Panel Number reference will be corrected in the Draft EIS.

Division of State Parks

We acknowledge the Division has no comments to offer at this time.

Division of Forestry and Wildlife

We acknowledge the Division has no comments to offer at this time.

Land Division, Hawaii District

We acknowledge the Division has no comments to offer at this time.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

PAUL J. CONRY
ACTING FIRST DEPUTY

LENORE N. OHIYE
ACTING DEPUTY DIRECTOR - WATER

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

October 22, 2010

EM

RECEIVED
OCT 25 2010
WILSON OKAMOTO CORPORATION

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania St., Suite 400
Honolulu, HI 96826

Dear Mr. Matsukawa:

Subject: Environmental Impact Statement Preparation Notice (EISPN) for proposed Kaloko Makai project.

The Division of Aquatic Resources' comments on the above Preparation Notice relate to the potential deleterious effects the project may have on adjacent nearshore marine waters and coral reef communities. The proposed project's makai boundary is less than one mile from the ocean and associated coral reefs. Additionally, it is directly mauka of the northern portion of Kaloko-Honokōhau National Historical Park and Kaloko fishpond.

The project is also in an area with substantial submarine groundwater discharge (SGD). As documented in a recent U.S. Geological Survey Study of coastal waters adjacent to the project (Grossman et. al 2010), nearshore waters in this area are persistently influenced by brackish water plumes derived from submarine groundwater discharge. These plumes extend hundreds of meters offshore to depths of 5 m and may contain several million to hundreds of millions of gallons of brackish water. In essence, the nearshore areas directly makai of the project are estuarine.

As such, the project must be regarded as a coastal development with substantial potential to impact marine water quality and coastal ecosystems. As stated in the USGS report changes in groundwater discharge are expected to have significant impacts to the area's coastal ecosystems, including decreased freshwater outflow to brackish anchialine pools and coral reefs and increased nutrient and contaminant concentrations.

The EISPN notes that a ground water resources and marine water quality assessment will be conducted for the Draft EIS to determine the anticipated impacts of the proposed project. Given the highly sensitive location of the project, in addition to a one-off water quality assessment, a rigorous long term monitoring program must be developed and implemented. The following concerns should be addressed in any such program. In 2004, the County of Hawaii contracted the Marine Science Department at the University of Hawai'i Hilo to evaluate monitoring data from development projects in West Hawai'i. Monitoring reports from 13 development projects were reviewed to evaluate water quality, microbiological, biological, geological and physical data collected during these projects. According to the report only three of the projects (Waikoloa, Natural Energy Laboratory of Hawaii Authority (NELHA) and Hokuli'a, contained sufficient data over a sufficient duration to evaluate temporal trends for water quality (and compliance

with DOH water quality standards). None of the other developments had sufficient data for long-term analyses. For most of the developments we really don't know what environmental impacts may be occurring due to changes in water quality.

The UH researchers were thus forced to use water quality data only from Waikoloa, NELHA and Hokuli'a to evaluate effects of resort/residential development on coastal water quality. With regard to anchialine ponds which are easily affected by adjacent land use practices, nutrient concentrations in both the Waikoloa and Hokuli'a ponds were found to be often higher than concentrations measured in highly polluted rivers and estuaries. The researchers estimated that nutrient concentrations in the anchialine ponds at Waikoloa more than doubled since the resort's development. They noted that likely sources of the nutrients to these ponds were irrigation water enriched with treated sewage used to water development grounds (Waikoloa), dry fertilizers applied to golf courses (Waikoloa), and remnant nutrients from historical agriculture and cattle grazing (Hokuli'a).

They further found that historical nearshore water quality analyses from Waikoloa and Hokuli'a revealed that nitrogen parameters significantly increased at both developments over the past ten years. Specifically, total nitrogen (TN) and dissolved organic nitrogen (DON) concentrations increased 49% and 107% respectively, at Waikoloa from 1991 to 2002. At Hokuli'a, all nutrient parameters showed significant increases in concentrations from 1991 to 2001, with NO3 concentrations exhibiting the largest concentration increase of 410%. They state that results from the analyses are consistent with historical temporal trends for the sites, suggesting that conditions in West Hawai'i may be developing for extreme environmental degradation, possibly resulting in algal blooms like those in West Maui. We are already experiencing such degradation as evidenced by the unprecedented outbreak of cyanobacteria (blue-green alga) at Honaunau over the past couple of years.

We also know from additional work at nearby Honokōhau Bay (Parsons et al. 2008) that nutrient inputs have increased there over the years, and the early impacts of this increased nutrient loading are already evident in the coral reef community. It is predicted that at current nutrient-loading rates, the south sites of Honokōhau Bay will undergo further degradation in future years. If millions of additional gallons of wastewater are to be added to the outflow from the Kealakehe Wastewater treatment plant as proposed, the environmental impacts and mitigation of such need to be fully addressed in the Environmental Impact Statement (EIS).

Finally the EISPN is wholly deficient in addressing potential impacts of the project to coastal marine biological resources. As noted above such impacts may result from increased levels of nutrients and contaminants in nearshore waters. These may be either from the project area itself (e.g. irrigation) or wastewater effluent from the treatment plant's seepage pit directly above Honokōhau bay. Additionally, if and when the project is completed, there will be tens of thousands of people living in the area where now there are none. It is likely that a substantial number of these new residents will avail themselves of the ocean recreation opportunities, including fishing and harvesting, offered by the nearby coastal marine areas. The potential impacts of these activities on our marine resources are real and need to be fully considered and mitigated in the EIS.

Sincerely,

ROBERT T. NISHIMOTO, Ph.D.
Program Manager

WILSON OKAMOTO
CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS

1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
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www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Robert T. Nishimoto, Ph.D., Program Manager
Division of Aquatic Resources
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street, Room 330
Honolulu, HI 96809

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Nishimoto:

Thank you for your letter dated October 22, 2010. We offer the following responses in the respective order of your comments:

1. The forthcoming DEIS will include a discussion on groundwater impacts associated with the proposed project.

2. The forthcoming DEIS will include a discussion on nearshore and marine resources impacts associated with the proposed project.

3. Kaloko Makai will participate and develop a groundwater monitoring plan.

4. The Draft EIS will discuss the potential impact to ground water resources and the nearshore marine environment, including coastal marine biological resources.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAI'I
DEPARTMENT OF LAND AND NATURAL RESOURCES
POST OFFICE BOX 621
HONOLULU, HAWAI'I 96809

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

PAUL J. CONRY
ACTING FIRST DEPUTY

LENORE N. OHYE
ACTING DEPUTY DIRECTOR - WATER

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

ref:OCCL:MC

Corr HA-11-60

RECEIVED
OCT 19 2010
WILSON OKAMOTO CORPORATION

OCT 18 2010

Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, HI 96826

Dear Mr. Matsukawa,

SUBJECT: **ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE**
Kaloko Makai Planned Community
Kaloko, North Kona, Hawai`i
TMK (3) 7-3-009:017

The Office of Conservation and Coastal Lands (OCCL) has reviewed the Environmental Impact Statement Preparation Notice for the proposed Kaloko Makai development on the above subject parcels.

Approximately 224 acres of the project area is in the General Subzone of the State Land Use Conservation District; the applicant is proposing to reclassify them as Urban in order to proceed with the development of a master planned community.

HAR §13-5 states that the objective of the General Subzone is *to designate open space where specific conservation uses may not be defined, but where urban use would be premature.*

As stated in our earlier correspondences, OCCL would like to see the EIS more fully explain why the applicant feels that these objectives are no longer applicable to the parcel in question.

Please contact Michael Cain at 587-0048 should you have any questions on this matter.

Sincerely,

for Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, HI 96809

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Lemmo:

Thank you for your letter dated October 28, 2010 (ref: OCCL:MC/Corr HA-11-60). We acknowledge that approximately 224 acres of the project area is designated Conservation District with a General Subzone designation. The Draft EIS will discuss how the project is in conformance with the Land Use Commission's decision-making criteria, Section 205-17, Hawaii Revised Statutes and Section 15-15-77, Hawaii Administrative Rules.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
DOH/CWB

10005PSS.10

October 5, 2010

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

Subject: Comments on the Environmental Assessment/Environmental Impact Statement Preparation Notice for Kaloko Makai
Kaloko and Kohanaiki, North Kona, Island of Hawaii, Hawaii
TMK: (3) 7-3-009:017, 025, 026, and 028

Dear Mr. Matsukawa:

The Department of Health (DOH), Clean Water Branch (CWB) has reviewed the subject document and offers these comments on the project. Please note that our review is based solely on the information provided in the subject document and its compliance with Hawaii Administrative Rules (HAR), Chapters 11-54 and 11-55. You may be responsible for fulfilling additional requirements related to our program. We recommend that you also read our standard comments on our website at http://www.hawaii.gov/health/environmental/env-planning/landuse/CWB-standardcomment.pdf.

1. Any project and its potential impacts to State waters must meet the following criteria:

   a. Antidegradation policy (HAR, Section 11-54-1.1), which requires that the existing uses and the level of water quality necessary to protect the existing uses of the receiving State water be maintained and protected.

   b. Designated uses (HAR, Section 11-54-3), as determined by the classification of the receiving State waters.

   c. Water quality criteria (HAR, Sections 11-54-4 through 11-54-8).

2. You may be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit for discharges of wastewater, including storm water runoff, into State surface waters (HAR, Chapter 11-55). For the following types of discharges into Class A or Class 2 State waters, you may apply for NPDES general permit coverage by submitting the applicable Notice of Intent (NOI) forms:

   a. Storm water associated with construction activities, including excavation, grading, clearing, demolition, uprooting of vegetation, equipment staging, and storage areas that result in the disturbance of equal to or greater than one (1) acre of total land area. The total land area includes a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules under a larger common plan of development or sale. An NPDES permit is required before the start of the construction activities.

   b. Storm water associated with industrial activities.

   c. Discharges of hydrotesting water.

   d. Discharges of construction activity dewatering.

   You must submit a separate NOI form for each type of discharge at least 30 calendar days prior to the start of the discharge activity, except when applying for coverage for discharges of storm water associated with construction activity. For this type of discharge, the NOI must be submitted 30 calendar days before the start of construction activities. The NOI forms may be picked up at our office or downloaded from our website at http://www.hawaii.gov/health/environmental/water/cleanwater/forms/genl-index.html.

3. For types of wastewater discharges not covered by an NPDES general permit or discharges to Class AA or Class 1 State waters, you may need an NPDES individual permit. An application for an NPDES individual permit must be submitted at least 180 calendar days before the commencement of the discharge. The NPDES application forms may be picked up at our office or downloaded from our website at http://www.hawaii.gov/health/environmental/water/cleanwater/forms/indiv-index.html. For your information, all waters within the Kaloko-Honokohau National Historical Park are classified as Class 1.

4. Please note that all discharges related to the project construction or operation activities, whether or not NPDES permit coverage is required, must comply with the State's Water Quality Standards. Noncompliance with water quality requirements contained in HAR, Chapter 11-54, and/or permitting requirements, specified in HAR, Chapter 11-55, may be subject to penalties of $25,000 per day per violation.

10005PSS.10

If you have any questions, please visit our website at http://www.hawaii.gov/health/environmental/water/cleanwater/index.html, or contact the Engineering Section, CWB, at (808) 586-4309.

Sincerely,

Joanna L Seto

for ALEC WONG, P.E., CHIEF
Clean Water Branch

SS:ml

c: DOH-EPO #I-3345 [via e-mail only]

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www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Alec Wong, Chief
Clean Water Branch
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, HI 96801-3378

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Wong:

Thank you for your letter dated October 5, 2010 (10005PSS.10). We offer the following responses in the respective order of your comments:

1. The Draft EIS will state that the proposed project will comply with HAR, Chapters 11-54 and 11-55, as applicable.

2. and 3. Kaloko Makai encompasses approximately 1,139 acres and is located approximately one mile east (mauka) of the shoreline. The coastal waters fronting the project site are classified as "AA" marine waters. Honokohau Bay, located immediately south of the project site is classified as "A" marine waters.

A National Pollutant Discharge Elimination System (NPDES) permit for discharges of wastewater, including storm water runoff, will be required for the proposed project. A NPDES Individual Permit will be required, as the coastal waters are classified as "AA."

NPDES for industrial activities, hydrotesting or dewatering is not anticipated. If one is needed, separate Notice of Intent (NOI) forms for each type of discharge will be submitted at least 30 calendar days prior to the start of discharge activity.

4. We acknowledge that all discharges related to the construction and operation activities must comply with the State of Hawaii Water Quality Standards.

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

EM

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. Box 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
File:

RECEIVED
OCT 27 2010
WILSON OKAMOTO CORPORATION

October 26, 2010

10-801A CAB

Mr. Earl Matsukawa, AICP
Wilson Okamoto Corporation
1907 S Beretania Street, Suite 400
Honolulu, Hawaii 96826

Dear Mr. Matsukawa:

SUBJECT: Kaloko Makai, EA/EIS Preparation Notice

A significant potential for fugitive dust emissions exists during all phases of construction. Proposed activities will occur in proximity to public areas and thoroughfares, thereby exacerbating potential dust problems.

We encourage the contractor to implement a dust control plan, which does not require approval by the Department of Health, and to comply with the provisions of Hawaii Administrative Rules, §11-60.1-33 on Fugitive Dust. Dust control measures, some of which are mentioned in your document, include, but are not limited to, the following:

a) Planning the different phases of construction, focusing on minimizing the amount of dust-generating materials and activities, centralizing on-site vehicular traffic routes, and locating potential dust-generating equipment in areas of the least impact;
b) Providing an adequate water source at the site prior to start-up of construction activities;
c) Landscaping and providing rapid covering of bare areas, including slopes, starting from the initial grading phase;
d) Minimizing dust from shoulders and access roads;
e) Providing adequate dust control measures during weekends, after hours, and prior to daily start-up of construction activities; and
f) Controlling dust from debris being hauled away from the project site.

If you have any questions, please contact Mr. Barry Ching of the Clean Air Branch at 586-4200.

Sincerely,

WILFRED K. NAGAMINE
Manager, Clean Air Branch

BC:smk

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7469-01
July 25, 2011

Mr. Wilfred K. Nagamine, Manager
Clean Air Branch
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, HI 96801-3378

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Nagamine:

Thank you for your letter dated October 26, 2010 (10-801A CAB). Air quality impacts during construction of the project will be mitigated by complying with Department of Health (DOH) Hawaii Administrative Rules (HAR), Title 11, Chapter 60, Air Pollution. The mitigation measures you recommended will be mentioned in the Draft EIS and will be implemented, as appropriate, during construction.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR

~~PATRICIA HAMAMOTO~~
~~XXXXXXXXXXXXXXXXX~~

KATHRYN S. MATAYOSHI
SUPERINTENDENT

STATE OF HAWAI'I
DEPARTMENT OF EDUCATION
P.O. BOX 2360
HONOLULU, HAWAII 96804

OFFICE OF THE SUPERINTENDENT

RECEIVED
OCT 19 2010
WILSON OKAMOTO CORPORATION

October 15, 2010

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

Dear Mr. Matsukawa:

SUBJECT: Environmental Assessment/Environmental Impact Statement Preparation Notice, Kaloko Makai, TMK (3) 7-3-09:017, 025, 026, and 028, Kaloko and Kohanaiki, North Kona, Hawaii

The Department of Education (DOE) has reviewed the Environmental Impact Statement Preparation Notice for the proposed Kaloko Makai project. The DOE has the following comments:

1. Impact and Impact Fees. Kaloko Makai will have a significant impact of the DOE's facilities in West Hawaii. Kaloko Makai is within the boundaries of the West Hawaii School Impact Fee District and will be subject to impact fees by the DOE. The fee amount will depend on the number of single-family and multi-family units in the project. The DOE requests additional information regarding the proposed mix of single-family and multi-family units.

2. School Sites. The conceptual land use plan for the project has two elementary school sites and one middle school site. However, as shown on the conceptual land use plan, a portion of the middle school site appears to be outside of the boundary of the project. Does the developer plan to acquire the portion of land outside the boundary of the project?

3. Phasing. The DOE would like to know any planned phasing for the project, and how that phasing relates to its school sites.

4. Discussion with Developer. The developer should meet with the DOE prior to the publication of the Draft Environmental Impact Statement to discuss and enter into an agreement regarding the school sites and impact fees.

Thank you for the opportunity to provide comments. If you have any questions, please call Jeremy Kwock of the Facilities Development Branch at 377-8301.

Very truly yours,

Kathryn S. Matayoshi
Superintendent

KSM:to

c: Art Souza, CAS, Honokaa/Kealakehe/Kohala/Konawaena Complex Areas

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER

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7469-01
July 25, 2011

Ms. Kathryn Matayoshi, Superintendent
Department of Education
State of Hawaii
P.O. Box 2360
Honolulu, HI 96804

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Ms. Matayoshi:

Thank you for your letter dated October 15, 2010. We offer the following responses in the respective order of your comments:

1. Impact and Impact Fees: We acknowledge the proposed project will be subject to impact fees by the Department of Education (DOE). The Draft EIS will include information on the number of single-family and multi-family units.

2. School Sites: The conceptual land plan in the EISPN identified sites for two elementary schools and one middle school. Since the EISPN, the schools sites have been relocated to lie within the Kaloko Makai project boundary.

3. Phasing: Kaloko Makai will be developed in three phases over the 30 years. A phasing plan will be included in the Draft EIS.

4. Kaloko Makai met with DOE Planning staff on July 21, 2011 to consult with DOE and discuss appropriate school impact fees.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD10/3552D

October 21, 2010

Earl Matsukawa, Project Manager
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawai'i 96826

RE: Environmental Impact Statement Preparation Notice
Kaloko Makai Development Project
Kaloko and Kohanaiki, North Kona, Hawai'i Island

Aloha e Earl Matsukawa,

The Office of Hawaiian Affairs (OHA) is in receipt of your September 17, 2010 request for comments on an Environmental Impact Statement Preparation Notice (EISPN) for the proposed SCD-TSA Kaloko Makai, LLC Development Project (project).

The forthcoming draft environmental impact statement (DEIS) will be the primary support document for a petition to the State Land Use Commission (LUC) requesting a District Boundary Amendment (DBA) and the reclassification of 224.430 acres from State Conservation to Urban and 727.735 acres from Agricultural to Urban. The DEIS will also serve to support any future use of State or County lands or funds during the development of the project. The full extent of such uses is unknown at this time. The LUC will be the accepting authority for the DEIS.

The project area will be situated on 1,142 acres of land, which includes the 952.165 acre LUC petition area. The EISPN details that at full build out, Kaloko Makai is envisioned to be a low and medium density residential community consisting of up to 5,000 single and multi-family units with commercial retail centers, recreational facilities and open spaces (including a 150 acre forest preserve), archaeological and cultural preserves, schools, a medical facility and associated infrastructure. The project will include an affordable housing component developed pursuant to County of Hawai'i requirements.

OHA recognizes that in concept, this project supports the broad goals, policies and standards of the Hawai'i County General Plan and elements of the Kona Community Development Plan. OHA respectfully asserts that the laudable aspects of any development project that has the potential to provide much needed employment, affordable housing and public services must be carefully balanced with the long term impacts that development will have on regional infrastructure, cultural landscapes and the quality of life for those who live within a given community.

The geographic area between Lanihau and Kalaoa Ahupua'a has been subject to intense development in recent years with additional projects planned into the foreseeable future as the urban center of North Kona is shifted away from Kailua Town. While conceptually providing the potential for relief, each new development provides constant pressure on regional infrastructure, resources and public services. We look forward to seeing the DEIS comprehensively analyzing this issue and offering mitigation measures that contribute to a new development paradigm.

In general, OHA opposes LUC reclassifications which result in the loss of agricultural lands with the potential to be productive to urban development. One of the fundamental objectives of the State Agricultural Function Plan (1991) is to encourage and develop diversified agriculture throughout Hawai'i which will support our local economy and contribute to reducing our dependence on imported products. We firmly believe this objective can be obtained by protecting and prioritizing initiatives on agricultural lands with the highest potential for productivity.

The majority (73%) of the project area has received a Land Study Bureau Overall Productivity rating of "E", representing the lowest possible agricultural productivity rating. Nearly 94% of the project area is not classified as Agricultural Lands of Importance in the State of Hawai'i. With this in mind, OHA acknowledges that if approved this reclassification will not have a significant impact on agricultural endeavors in Hawai'i.

The DEIS should specifically discuss the impacts the reclassification the 224.430 acre parcel (parcel) from Conservation to Urban. This parcel is located directly across Queen Ka'ahumanu Highway from Kaloko-Honokohau National Historical Park and development has the potential to directly impact view planes and the water quality of Kaloko and Aimakapa fishponds. While the current classification of the 150 acres of land which will be designated as a forest reserve is unclear to us at this time, if it is currently Conservation, we urge consideration of allowing it to remain so. If the forest reserve area is not Conservation at this time, we urge consideration of classifying it as such via the pending LUC petition.

We are pleased to see that an archaeological inventory survey and cultural impact assessment will be conducted and incorporated into the DEIS. OHA applauds the developer for affording consideration to the preservation of cultural sites situated within and the historic trail which traverses the project area. OHA is aware that the preservation of the segment of this trail and cultural sites which are situated within the "Kaloko Heights" development (which is immediately adjacent to the project area) were major concerns to the Kona community. We look forward to seeing an archaeological inventory survey and appropriate mitigation plans reviewed

and approved by the Department of Land and Natural Resources- State Historic Preservation Division.

In addition to the agencies and parties listed as being consulted within Section 8 of the EISPN, we hope you will engage in a broad and proactive public outreach effort during the development of the DEIS. Thank you for the opportunity to provide comments and we look forward to reviewing the DEIS. Should you have any questions, please contact Keola Lindsey at 594-0244 or keolal@oha.org.

'O wau iho nō me ka 'oia'i'o,

Clyde W. Nāmu'o
Chief Executive Officer

C: OHA Trustee Robert K. Lindsey, Jr.
OHA- West Hawai'i Community Resources Coordinator

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7469-01
July 25, 2011

Mr. Clyde M. Namuo, Administrator
Office of Hawaiian Affairs
State of Hawaii
711 Kapiolani Boulevard, Suite 500
Honolulu, HI 96813

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Namuo:

Thank you for your letter dated October 21, 2010 (HRD10/3552D). We offer the following responses in the respective order of your comments:

1. According to the ALISH, approximately 6 percent of the project site is designated "other" and the remainder of the project site is not classified. Kaloko Makai will not have an impact on agriculturally significant lands. A discussion and maps on ALISH and LSB ratings and designations for the project site will be included in the Draft EIS.

   We acknowledge OHA's concurrence that the proposed project will not have a significant impact on agricultural lands and endeavors.

2. We concur that approximately 224 acres of the project area is designated Conservation District with a General Subzone designation. The Draft EIS will discuss how the project is in conformance with the Land Use Commission's decision-making criteria, Section 205-17, Hawaii Revised Statutes and Section 15-15-77, Hawaii Administrative Rules.

   Flora and fauna surveys have been conducted for the project site. The findings of these surveys will be summarized and reports reproduced in their entirety in the Draft EIS. Potential impacts and mitigation measures will be discussed.

   Kaloko Makai has been working with the US Fish & Wildlife Service and the Department of Land and Natural Resources on the delineation and preservation of the 150 acre native dryland forest. It has been determined that the project may cause the taking of two listed plant species (`aiea and hala pepe) and one candidate species (ko`oko`olau). As a result, Kaloko Makai has prepared a Habitat Conservation Plan (HCP) to develop short- and long-term management measures to protect these species.

3. An archaeological inventory survey and a cultural impact assessment have been prepared and will be included in the Draft EIS. Related impacts and mitigation measures will be discussed.

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR
STATE OF HAWAII

KAULANA H. R. PARK
CHAIRMAN
HAWAIIAN HOMES COMMISSION

ANITA S. WONG
DEPUTY TO THE CHAIRMAN

ROBERT J. HALL
EXECUTIVE ASSISTANT

EM

STATE OF HAWAI'I
DEPARTMENT OF HAWAIIAN HOME LANDS
P.O. BOX 1879
HONOLULU, HAWAI'I 96805

RECEIVED
OCT 14 2010
WILSON OKAMOTO CORPORATION

October 7, 2010

Mr. Earl Matsukawa, AICP
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

Dear Mr. Matsukawa:

Subject: Environmental Assessment Preparation Notice, Kaloko Makai, Kaloko and Koanaiki, North Kona, Hawaii

Mahalo for your letter of September 17, 2010, providing an opportunity to comment on the subject project.

The department has major landholdings to the south (Kealakehe) and north (Kalaoa) of Kaloko and Koanaiki. The department is concerned about major infrastructure running north - south, serving this region, and recommend that the final Environmental Assessment include a discussion on:

1. Means of financing the Ane Keohokalole Highway which should be extended from Kealakehe to Kalaoa.

2. Improvements to the North Kona Water System may be needed to accommodate more growth. Kaloko Makai water improvements should be coordinated with other developers, including Hawaiian home lands at Kealakehe.

3. The wastewater plant at Kealakehe may require expansion to accommodate Kaloko Makai. The community has expressed concerns about odors from the wastewater plant. Discuss measures to be taken to eliminate this problem.

4. A major community and social services center is planned for Kealakehe which will serve the entire region. To the extent that Kaloko Makai will generate the need for more

Services, the developer should consider a community benefits package to support this effort.

If you have any questions, please contact Darrell Yagodich, Planning Program Manager, at 620-9481.

Aloha and mahalo,

Anita S. Wong

Kaulana H.R. Park, Chairman
Department of Hawaiian Home Lands

Cc: Bo Kahui, Laiopua 2020
Dora Aio-Leamons, Kaniohale at the Villages of Laiopua

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7469-01
July 25, 2011

Mr. Albert "Alapaki" Nahale-a Chairman
Department of Hawaiian Home Lands
State of Hawaii
PO Box 1879
Honolulu, HI 96805

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Nahale-a:

Thank you for your letter dated October 7, 2010. We offer the following responses in the respective order of your comments:

1. Ane Keohokalole Highway: Phase 1, Palani Road to Hina Lani is under construction. Kaloko Makai will construct Ane Keohokalole from Hina Lani to Hulikoa Road. We understand that further extension of Ane Keohokalole will be achieved through a combination of public and private funding.

2. North Kona Water System: Kaloko Makai's water demand will require additional water source, storage and transmission facilities, which will be privately constructed in conjunction with the project. These facilities will be developed in coordination with the County Department of Water Supply.

   Kaloko Makai is investigating several alternatives for its potable water needs. The Draft EIS will discuss water resources and the potential impact to groundwater resources and the nearshore marine environment.

3. Wastewater: In the event connection to a public wastewater system is not available, Kaloko Makai will construct and operate a private Wastewater Treatment Plant (WWTP) to serve the development within the project. It will treat the wastewater to produce reclaimed (R-1) water for general irrigation within Kaloko Makai, thus lessening demand for potable water. The Draft EIS will discuss potential impacts and mitigation measures associated with the wastewater treatment and reuse.

4. Community Benefits Package: Kaloko Makai will be setting aside land for a hospital, judiciary complex, three school sites, and fire/police station. In addition, Kaloko Makai will also be preserving the 150-acre dryland forest and historic trails. These proposed actions will benefit the surrounding community.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

William P. Kenoi
Mayor

William T. Takaba
Managing Director

Walter K.M. Lau
Deputy Managing Director

County of Hawai'i
Office of the Mayor
25 Aupuni Street, Suite 2603 • Hilo, Hawai'i 96720 • (808) 961-8211 • Fax (808) 961-6553
KONA: 75-5722 Hanama Place, Suite 102 • Kailua-Kona, Hawai'i 96740
(808) 327-3602 • Fax (808) 326-5663

October 8, 2010

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 S. Beretania Street, Suite 400
Honolulu, HI 96826

Subject: Environmental Assessment/Environmental Impact Statement Preparation Notice
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawai'i
TMK: (3) 7-3-09: 017, 125, 026 and 028

Dear Mr. Matsukawa:

Thank you for the opportunity to review the EISPN for the Kaloko Makai project being proposed by Stanford Carr Development LLC. We have had the pleasure to work with SCD during the last six months on a feature of this property, the dryland forest preserve, which is adjacent to the Ane Keohokalole Highway, now under construction by the County of Hawai'i. SCD's commitment to the protection of this preserve is indisputable.

We have no comments at this time, but would like to reserve the right to comment when the draft environmental impact statement is issued for this project.

Aloha,

Billy Kenoi
MAYOR

County of Hawai'i is an Equal Opportunity Provider and Employer.

EM
TR

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OCT 12 2010
WILSON OKAMOTO CORPORATION

WILSON OKAMOTO CORPORATION
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www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. William P. Kenoi, Mayor
Office of the Mayor
County of Hawaii
25 Aupuni Street
Hilo, HI 96720

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Kenoi:

Thank you for your letter dated October 8, 2010. We appreciate your past support and look forward continuing to work with the County, Department of Land and Natural Resources and US Fish & Wildlife Service in delineating and preserving the 150-acre native dryland forest. While you have no additional comments at this time, your further input as this project proceeds is welcome.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

William P. Kenoi
Mayor

BJ Leithead Todd
Planning Director

Margaret K. Masunaga
Deputy Planning Director

County of Hawaii

PLANNING DEPARTMENT
Aupuni Center • 101 Pauahi Street, Suite 3 • Hilo, Hawaii 96720
Phone (808) 961-8288 • Fax (808) 961-8742

October 21, 2010

Post-it® Fax Note 7671	Date 3/30/11	# of pages ▸ 3
To Tracy Fukuda	From Deanne Bugado	
Co./Dept. Wilson Okamoto	Co. COH - Planning	
Phone #	Phone # 327-3770	
Fax # 944-2253	Fax # 327-3563	

Mr. Earl Matsukawa, AICP
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, HI 96826

Dear Mr. Matsukawa:

Re: Preparation Notice for an Environmental Impact Statement (EIS)
Kaloko Makai
TMK: (3) 7-3-009:017, 025, 026 and 028

This is to acknowledge receipt of your September 17, 2010 letter requesting our comments on the proposed Kaloko Makai project. We have reviewed the EIS preparation notice for the Kaloko Makai project and have the following comments to offer:

1. Parcel 7-3-009:017 is designated Conservation by the State Land Use Commission. It is zoned Agricultural (A-5a) by the County. According to the Land Use Pattern Allocation Guide Map of the General Plan, the parcel is designated Urban Expansion.
2. Parcel 7-3-009:025 is designated Urban and Agricultural by the State Land Use Commission. It is zoned Agricultural (A-5a) by the County. According to the Land Use Pattern Allocation Guide Map of the General Plan, the parcel is designated Urban Expansion.
3. Parcel 7-3-009:026 is designated Agricultural by the State Land Use Commission. It is zoned Agricultural (A-5a) by the County. According to the Land Use Pattern Allocation Guide Map of the General Plan, the parcel is designated Urban Expansion.
4. Parcel 7-3-009:028 is designated Agricultural by the State Land Use Commission. It is zoned Agricultural (A-5a) by the County. According to the Land Use Pattern Allocation Guide Map of the General Plan, the parcel is designated Conservation and Urban Expansion.
5. This parcel is not located in the County's Special Management Area. Therefore, Special Management Area rules and regulations are not applicable.
6. The Kona Community Development Plan has designated the proposed parcels in the Kona Urban Area and have further designated a Transit Oriented Development for this area. The project falls within the KCDP's "C" Concurrency Zone.

Hawai'i County is an Equal Opportunity Provider and Employer

7. The Project Description states that a Hospital/Medical Center will be provided and there is an anticipated "upgrade" to a Regional Center designation for the project's Transit Oriented Development, however the Department cannot support such a change without a firm/written commitment with a medical service.
8. Special Permit No. 499 was issued to the Hawaii County Police Department in 1981 for a pistol shooting range within the property owned by Lanihau Properties (TMK 7-4-008:005) which is located just south of the Kaloko Makai project site. Please contact Lanihau Properties or the Police Department to determine if this shooting range is still in operation, as noise from it may negatively impact the residents of the proposed development.
9. Since March 2008, emissions of SO_2 from Halema'uma'u have increased significantly. Therefore, the air quality analysis being prepared for the EIS should use the most current State DOH air quality monitoring data
10. Will the historic trail (the Road to the Sea) be split by the mid-level road, or will there be a grade separation to allow pedestrians to walk its entire length?
11. The General Plan identifies the view plane along Queen Ka'ahumanu Highway going mauka and makai as an area of natural beauty because of its openness and expansiveness. The EIS should show how the proposed project will affect the sense of openness in this area by including photographic simulations of the project from various view points along the highway.
12. The TIAR should contain the information required in Zoning Code Section 25-2-46 (enclosed), and include an analysis of the proposed project on the regional roadway system. In addition, to provide the most accurate determination of level of service (LOS) at study intersections, the TIAR should include the following methods: take on-ground time delay studies, determine the queue lengths when traffic counts are taken, and adjust the saturated flow in the modeling software until the queue lengths and the time delay match the actual on-ground conditions.
13. Lastly, we recommend you consult with the State DLNR, Division of Forestry and Wildlife, Na Ala Hele Program regarding the historical trail that runs through the property.

Thank you for requesting our participation in the EIS preparation process. Please provide this office with a copy of the EIS upon its publication. Should you have questions, please contact Deanne Bugado at 327-3510.

Sincerely,

for BJ LEITHEAD TODD
Planning Director

DLB:dab
K:\Staff\Deanne\Letters\Prep-Notice EIS - Kaloko Makai.doc

Enclosure

cc: Mr. Daryn Arai, Planning Division
Planning Department- Kona

7469-01
July 25, 2011

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
FAX: 808-946-2253
www.wilsonokamoto.com

Ms. Bobby Jean Leithead-Todd, Director
Planning Department
County of Hawaii
Aupuni Center
101 Pauahi Street, Suite 3
Hilo, HI 96720

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Ms. Leithead-Todd:

Thank you for your letter dated October 21, 2010. We offer the following responses in the respective order of your February 13, 2008 comments:

1. We acknowledge that Parcel 7-3-009: 017 is designated Conservation by the State Land Use Commission (SLUC), zoned Agricultural (A-5a) by the County, and designated Urban Expansion according to Land Use Pattern Allocation Guide Map (LUPAG).

2. We acknowledge that Parcel 7-3-009: 025 is designated Urban and Agricultural by the State Land Use Commission (SLUC), and designated Urban Expansion according to Land Use Pattern Allocation Guide Map (LUPAG). The parcel is zoned Open by the County.

3. We acknowledge that Parcel 7-3-009: 026 is designated Agricultural by the State Land Use Commission (SLUC), zoned Agricultural (A-5a) by the County, and designated Urban Expansion according to Land Use Pattern Allocation Guide Map (LUPAG).

4. We acknowledge that Parcel 7-3-009: 028 is designated Agricultural by the State Land Use Commission (SLUC), zoned Agricultural (A-5a) by the County, and designated Urban Expansion and Conservation according to Land Use Pattern Allocation Guide Map (LUPAG).

5. We acknowledge that the project site is not located in the County's Special Management Area (SMA). Therefore, SMA rules and regulations are not applicable.

6. We acknowledge that the project site is located within the Kona Community Development Plan's (CDP) Kona Urban Area; is designated a Transit Oriented Development; and located within Concurrency Zone "C."

7. Kaloko Makai is setting aside land for a Hospital/Medical Center. We acknowledge that Kaloko Makai is designated as a Neighborhood TOD, and the County will not "upgrade" to a Regional TOD, until there is a firm commitment with a medical service.

8. We will contact Lanihau Partners and/or the County Police Department to determine if they are still proposing a pistol shooting range on TMK 7-4-008:005.

9. An air quality study is being prepared for the project and will be included in the Draft EIS. The analysis will use the most current State DOH air quality monitoring data.

10. The historic Kohanaiki Trail (Road to the Sea) will be preserved. We continue to consult with Na Ala Hele and the National Park Service, Ala Kahakai National Historic Trail on the alignment of the trail through the project site. Ane Keohokalole Highway will cross the trail.

11. We acknowledge that the General Plan identifies the view plane along Queen Kaahumanu going mauka and makai as an area of natural beauty. The Draft EIS will include a discussion on visual impacts.

12. The Draft EIS will include a Traffic Impact Assessment Report (TIAR) that will address access and traffic issues, as well as provide mitigation measures regarding potential adverse impacts.

13. As stated previously, we continue to consult with Na Ala Hele, the National Park Service, Ala Kahakai National Historic Trail on the alignment of the Kohanaiki Trail (Road to the Sea) through the project site.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAI'I
345 KEKŪANAŌ'A STREET, SUITE 20 • HILO, HAWAI'I 96720
TELEPHONE (808) 961-8050 • FAX (808) 961-8657

October 25, 2010

RECEIVED
OCT 27 2010
WILSON OKAMOTO CORPORATION

Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, HI 96826

ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
APPLICANT: SCD – TSA KALOKO MAKAI, LLC
TAX MAP KEY 7-3-009:017, 025, 026, AND 028

We have reviewed the subject Environmental Impact State Preparation Notice and have the no further comments at this time. Our comments, noted in our February 13, 2008 letter to the County of Hawai'i, Planning Department regarding the applicant's State Land Use Boundary Amendment (A07-778) for the subject project, remains unchanged. A copy of our February 13, 2008 letter is enclosed for your information.

Should there be any questions, you may contact Mr. Finn McCall of our Water Resources and Planning Branch at 961-8070, extension 255.

Sincerely yours,

Milton D. Pavao, P.E.
Manager

FM:dfg

Enc.

copy – SCD – TSA Kaloko Makai, LLC

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAI'I
345 KEKŪANAŌ'A STREET, SUITE 20 • HILO, HAWAI'I 96720
TELEPHONE (808) 961-8050 • FAX (808) 961-8657

February 13, 2008

TO: Mr. Christopher J. Yuen, Planning Director
Planning Department

FROM: Milton D. Pavao, Manager

SUBJECT: STATE LAND USE BOUNDARY AMENDMENT A07-778 AND ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
APPLICANT – SCD KALOKO MAKAI, LLC
REQUEST: CONSERVATION AND AGRICULTURAL TO URBAN
TAX MAP KEY 7-3-009:017, 025 (PORTION), 026, AND 028

We have reviewed the subject Petition for State Land Use Boundary Amendment and Environmental Impact State Preparation Notice and have the following comments.

Please be informed that the Department's existing water system cannot support the proposed development at this time. Extensive additions and improvements would be required, which may include, but not be limited to, source, storage, booster pumps, transmission, and distribution facilities. Currently, funding is not available and no time schedule is set for such improvements by the Department.

The Department has no objection to the proposed request, subject to the applicant providing the offsite and onsite water system improvements necessary to adequately serve the development. All elements of the offsite and onsite water system improvements shall be constructed in accordance with the Department's Water System Standards and Rules and Regulations. Further, the improvements must be properly accepted by and dedicated to the Water Board before water service can be granted.

The developer will be required to enter into a Water Development Agreement with the Water Board in order to establish, among other things, the scope of the water system improvements needed to support the development, water allocation from any newly developed sources, and timeline for completion of said improvements. The Department will provide its comments on the scope of the necessary water system improvements upon review of the Preliminary Engineering Report to be submitted with the Draft Environmental Impact Statement.

Should there be any questions, you may contact Mr. Finn McCall of our Water Resources and Planning Branch at 961-8070, extension 255.

Sincerely yours,

Milton D. Pavao, P.E.
Manager

FM:dfg

copy – SCD Kaloko Makai, LLC
Carlsmith Ball LLP
Wilson Okamoto Corporation
State of Hawaii, State Land Use Commission

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
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Honolulu, Hawaii, 96826 USA
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www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Milton Pavao, Manager
Department of Water Supply
County of Hawaii
345 Kekuanaoa St., Suite 20
Hilo, HI 96720

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Pavao:

Thank you for your letter dated October 25, 2010. We acknowledge that you have no comments to offer at this time and your previous comments dated February 13, 2008 remains unchanged. We offer the following responses in the respective order of your February 13, 2008 comments:

1. We acknowledge the Department's existing water system cannot support the proposed project at this time.

2. Kaloko Makai's water demand will require additional water source, storage and transmission facilities. The proposed project will construct the required water system facilities. Kaloko Makai is investigating several alternatives for its potable water needs. The Draft EIS will discuss water resources and the potential impact to ground water resources and the nearshore marine environment.

3. On-site and off-site water improvements shall be constructed in accordance with the Department's Water System Standards and Rules and Regulations.

4. We acknowledge Kaloko Makai will be required to enter into a Water Development Agreement with the Water Board in order to establish, among other things, the scope of water system improvements needed to support the proposed project.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

EM
7 F

William P. Kenoi
Mayor

William T. Takaba
Managing Director

Frank J. DeMarco, P.E.
Director

Ivan M. Torigoe
Deputy Director

County of Hawai'i
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
25 Aupuni Street • Hilo, Hawai`i 96720
(808) 961-8083 · Fax (808) 961-8086
http://co.hawaii.hi.us/directory/dir_envmng.htm

October 13, 2010

RECEIVED
OCT 19 2010
WILSON OKAMOTO CORPORATION

Wilson Okamoto Corporation
1907 South Beretania
Honolulu, HI 96826

Attention: Mr. Earl Matsukawa, AICP
Project Manager

RE: Environmental Assessment (EA)/Environmental Impact Statement
Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawai`i
TMK:7-3-09:017, 025, 026 and 028

Dear Mr. Matsukawa,

We offer the following comments:

Solid Waste Division
Please submit a Solid Waste Management Plan in accordance with enclosed guidelines.

Thank you for allowing us to review and comment on this project.

Sincerely,

Frank DeMarco

Frank J. DeMarco, P.E.
DIRECTOR

enclosure

cc: SWD

County of Hawai'i is an Equal Opportunity Provider and Employer.

WILSON OKAMOTO CORPORATION
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7469-01
July 25, 2011

Mr. Frank J. DeMarco, P.E., Director
Department of Enviromental Management
County of Hawaii
25 Aupuni Street
Hilo, HI 96720

Subject: Environmental Assessment (EA)/Environmental Impact Statement
Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. DeMarco:

Thank you for your letter dated October 13, 2010. At the appropriate phase project design and development, a Solid Waste Management Plan will be prepared and submitted to the Solid Waste Division.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

William P. Kenoi
Mayor

County of Hawai'i
POLICE DEPARTMENT
349 Kapi'olani Street • Hilo, Hawai'i 96720-3998
(808) 935-3311 • Fax (808) 961-2389

Harry S. Kubojiri
Police Chief

Paul K. Ferreira
Deputy Police Chief

October 11, 2010

Mr. Earl Matsukawa, AICP
Project Manager
Wilson Okamoto Corporation
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii 96826

RECEIVED
OCT 15 2010
WILSON OKAMOTO CORPORATION

Dear Mr. Matsukawa:

SUBJECT: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09:017, 025, 026, and 028

The above-referenced Environmental Impact Statement Preparation Notice (EISPN) for the proposed Kaloko Makai project has been reviewed, and we have the following concerns.

A development of this size will increase traffic on all roadways associated with the development. Major roadways affected will include Hina Lani Street, Mamalahoa Highway, Queen Kaahumanu Highway, and Palani Road. We request the opportunity to comment on the Traffic Impact Assessment Report (TIAR), upon its completion.

The EISPN also acknowledges that the proposed project will require an increase in police staffing and possible expansion of existing police facilities. Funding for these required increases should be identified and addressed.

Thank you for the opportunity to comment. Should you have any questions, please contact Major Randy Apele, Area II Operations, at (808) 326-4646 ext. 270.

Sincerely,

HARRY S. KUBOJIRI
POLICE CHIEF

HENRY J. TAVARES JR.
ASSISTANT POLICE CHIEF
AREA II OPERATIONS

RA:dmv
RS100754

"Hawai'i County is an Equal Opportunity Provider and Employer"

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www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Harry S. Kubojiri, Chief of Police
Police Department
County of Hawaii
349 Kapiolani Street
Hilo, HI 96720

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Kubojiri:

Thank you for your letter dated October 11, 2010. The Draft EIS will include a Traffic Impact Assessment Report (TIAR) addressing access and traffic issues, as well as recommend mitigation measures regarding potential adverse impacts.

Kaloko Makai will coordinate with the Police Department to address service capabilities of police operations, address concerns, and develop appropriate mitigation measures, as appropriate.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

William P. Kenoi
Mayor

Darryl J. Oliveira
Fire Chief

Glen P. I. Honda
Deputy Fire Chief

County of Hawai'i

HAWAI'I FIRE DEPARTMENT
25 Aupuni Street • Suite 2501 • Hilo, Hawai'i 96720
(808) 932-2900 • Fax (808) 932-2928

RECEIVED
OCT 22 2010
WILSON OKAMOTO CORPORATION

October 11, 2010

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawai'i 96826

SUBJECT: ENVIRONMENTAL ASSESSMENT (EA)/ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE (EISPN)
KALOKO MAKAI
KALOKO AND KOHANAIKI, NORTH KONA, HAWAII
TMK: (3) 7-3-09:017, 025, 026 AND 028

In regards to the above-mentioned environmental assessment and environmental impact statement preparation notice, the following shall be in accordance:

Fire apparatus access roads shall be in accordance with UFC Section 10.207:

"Fire Apparatus Access Roads

"Sec. 10.207. (a) **General.** Fire apparatus access roads shall be provided and maintained in accordance with the provisions of this section.

"(b) **Where Required.** Fire apparatus access roads shall be required for every building hereafter constructed when any portion of an exterior wall of the first story is located more than 150 feet from fire department vehicle access as measured by an unobstructed route around the exterior of the building.

"**EXCEPTIONS:** 1. When buildings are completely protected with an approved automatic fire sprinkler system, the provisions of this section may be modified.

"2. When access roadways cannot be installed due to topography, waterways, nonnegotiable grades or other similar conditions, the chief may require additional fire protection as specified in Section 10.301 (b).

"3. When there are not more than two Group R, Division 3 or Group M Occupancies, the requirements of this section may be modified, provided, in the opinion of the chief, fire-fighting or rescue operations would not be impaired.

"More than one fire apparatus road may be required when it is determined by the chief that access by a single road may be impaired by vehicle congestion, condition of terrain, climatic conditions or other factors that could limit access.

"For high-piled combustible storage, see Section 81.109.

"(c) **Width.** The unobstructed width of a fire apparatus access road shall meet the requirements of the appropriate county jurisdiction.

"(d) **Vertical Clearance.** Fire apparatus access roads shall have an unobstructed vertical clearance of not less than 13 feet 6 inches.

"**EXCEPTION:** Upon approval vertical clearance may be reduced, provided such reduction does not impair access by fire apparatus and approved signs are installed and maintained indicating the established vertical clearance.

"(e) **Permissible Modifications.** Vertical clearances or widths required by this section may be increased when, in the opinion of the chief, vertical clearances or widths are not adequate to provide fire apparatus access.

"(f) **Surface.** Fire apparatus access roads shall be designed and maintained to support the imposed loads of fire apparatus and shall be provided with a surface so as to provide all-weather driving capabilities." (20 tons)

"(g) **Turning Radius.** The turning radius of a fire apparatus access road shall be as approved by the chief." (45 feet)

"(h) **Turnarounds.** All dead-end fire apparatus access roads in excess of 150 feet in length shall be provided with approved provisions for the turning around of fire apparatus.

"(i) **Bridges.** When a bridge is required to be used as access under this section, it shall be constructed and maintained in accordance with the applicable sections of the Building Code and using designed live loading sufficient to carry the imposed loads of fire apparatus.

"(j) **Grade.** The gradient for a fire apparatus access road shall not exceed the maximum approved by the chief." (15%)

"(k) **Obstruction.** The required width of any fire apparatus access road shall not be obstructed in any manner, including parking of vehicles. Minimum required widths and clearances established under this section shall be maintained at all times.

"(l) **Signs.** When required by the fire chief, approved signs or other approved notices shall be provided and maintained for fire apparatus access roads to identify such roads and prohibit the obstruction thereof or both."

Water supply shall be in accordance with UFC Section 10.301(c):

"(c) **Water Supply.** An approved water supply capable of supplying required fire flow for fire protection shall be provided to all premises upon which buildings or portions of buildings are hereafter constructed, in accordance with the respective county water requirements. There shall be provided, when required by the chief, on-site fire hydrants and mains capable of supplying the required fire flow.

"Water supply may consist of reservoirs, pressure tanks, elevated tanks, water mains or other fixed systems capable of providing the required fire flow.

"The location, number and type of fire hydrants connected to a water supply capable of delivering the required fire flow shall be protected as set forth by the respective county water requirements. All hydrants shall be accessible to the fire department apparatus by roadways meeting the requirements of Section 10.207.

DARRYL OLIVEIRA
Fire Chief

RP:lpc

7469-01
July 25, 2011

WILSON OKAMOTO CORPORATION
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FAX: 808-946-2253
www.wilsonokamoto.com

Mr. Darryl J. Oliveira, Fire Chief
Fire Department
County of Hawaii
25 Aupuni Street
Hilo, HI 96720

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Oliveira:

Thank you for your letter dated October 11, 2010. Within the Kaloko Makai project, fire apparatus access roads shall be developed in accordance with Uniform Fire Code Section 10.207 and the water supply for fire protection shall be developed in accordance with UFC Section 10.301(c).

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

Hawaii Electric Light Company, Inc. • PO Box 1027 • Hilo, HI 96721-1027

EM TF

October 1, 2010

RECEIVED
OCT 04 2010
WILSON OKAMOTO CORPORATION

Wilson Okamoto Corporation
Attn: Mr. Earl Matsukawa, AICP
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, HI 96826

Gentlemen:

SUBJECT: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
TMK: 7-3-009:017, 025, 026 and 028
Kaloko Makai, North Kona, Island of Hawaii

Thank you for the opportunity to comment on the subject's Environmental Impact Statement Preparation Notice (EISPN). HELCO will be able to provide electrical service to the proposed development in North Kona. A detailed analysis will be performed after the receipt of the consultant's detailed design drawings and estimated load. The following is a summary of our comments:

1. Generation capacity – HELCO's current system peak load is 194,600kW and our total generation system capability is 285,800kW. Our reserve margin is 37% and may have adequate generation to serve the above.

2. Electrical Substation – The area is served by our existing Kaloko electrical substation and a 12,470 volt underground distribution along Hina Lani Street. The capacity of our existing substation is <u>not</u> adequate to serve the anticipated load. A lot with a minimum size of 250' x 250' must be deeded to HELCO for the construction of a new substation.

3. Off-Site Electrical Transmission System – The existing 69,000 volt transmission line along Queen Kaahumanu Highway will need to be extended to the new electrical substation.

4. Off-Site Electrical Distribution System – The existing off-site 12,470 volt distribution system along Hina Lani Street is <u>not</u> adequate to serve the proposed development. Off-site 12,470 volt distribution lines and easements from the new substation to the on-site development are required to serve the anticipated load.

5. On-Site Electrical Distribution System – On-site distribution line extensions and easements are required on the developer's property to serve the anticipated load.

After the development's detailed loading and civil plans are submitted, HELCO will prepare a firm cost to provide electrical power to this development.
HELCO recommends energy efficient and conservation measures to reduce the maximum electrical demand and energy consumption. The developer may call HELCO's Energy Services department at (808) 935-1171 for questions or details on available programs.

It is encouraged that the developer's electrical consultant open a service request with HELCO Engineering department as soon as practicable to ensure timely electrical facility installation. If you have any questions, please contact myself or Shelley Doctor at (808) 327-0504.

Sincerely,

Thomas W. Cummins

Thomas W. Cummins, L.P.L.S.
Manager, Engineering Department
Hawaii Electric Light Co., Inc.

TWC:HKK:sm

Enclosures

cc: S. Tomita
K. Whitener
L. Rogers

2. PROJECT DESCRIPTION

2.1 Project Description

SCD - TSA Kaloko Makai, LLC proposes to develop Kaloko Makai, a residential mixed-use development, on approximately 1,142 acres of undeveloped land in Kaloko and Kohanaiki, North Kona, and Hawaii. Kaloko Makai will be a totally master planned residential community, with supporting commercial, light-industrial, educational, recreational, open space uses and their related infrastructure. This diverse project will entail construction of up to 5,000 new single- and multi-family residential units at low- and medium-densities, centralized commercial and neighborhood retail centers, an array of recreational facilities (e.g. parks, trails, open spaces), urgent care medical facility, a new elementary school, a middle school, and associated infrastructure (e.g., new roadways, utilities, drainage, wastewater and potable and non-potable water distribution systems). The community development will satisfy a wide range of primary market housing needs, including the provision of affordable housing as required by the County of Hawaii. Figure 2-1 illustrates the proposed Conceptual Land Use Plan. See Table 2-1 below for proposed land use categories and acreages.

Table 2-1
Estimated Allocation by Land Use Type

Land Use Type	Estimated Area (Acres)
Urban Center (T5, high density)	229
General Urban (T4, med. density)	193
Sub-Urban (T3, low density)	106
Dryland Forest	150
Schools	34
Hospital/Medical Center	20
Open Space/Civic Space	103
Wastewater Treatment Plan	24
Light Industrial/Commercial/Retail	153
Roadways/Utilities	130
Total	1,142

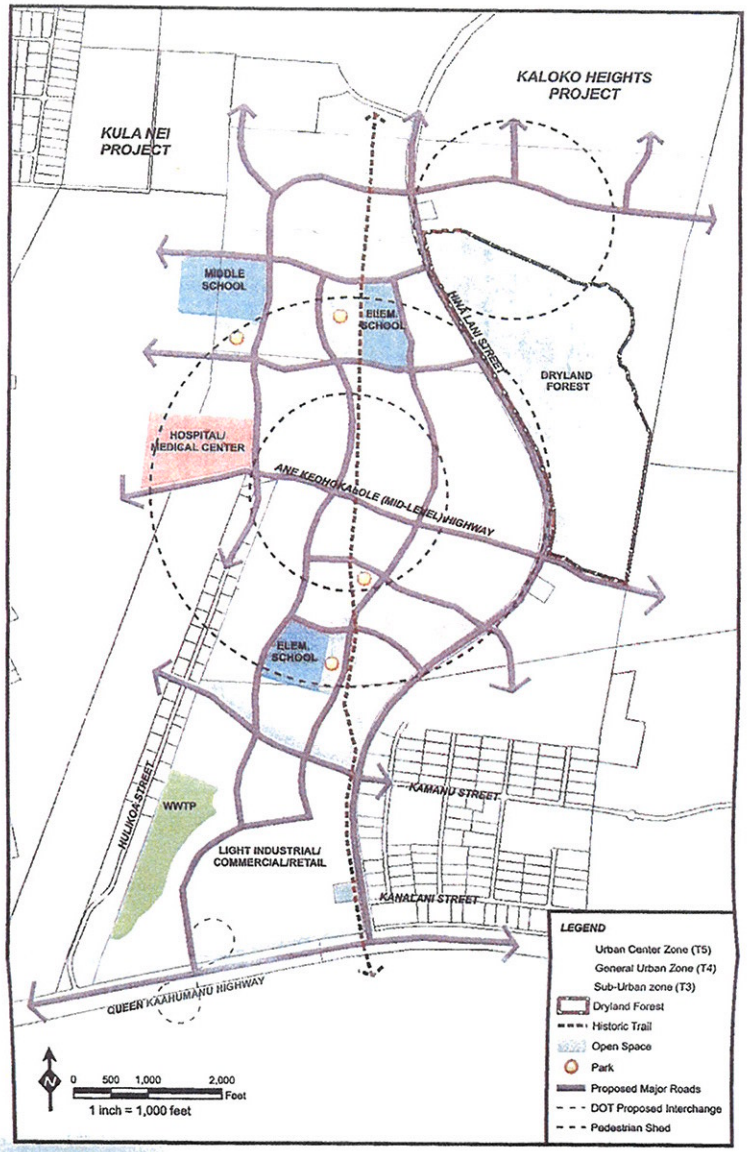

FIGURE 2-1
Conceptual Land Use Map
Kaloko Makai

WILSON OKAMOTO
CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS

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FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Thomas W. Cummins, L.P.L.S., Manager
Engineering Department
Hawaii Electric Light Company
P.O. Box 1027
Hilo, Hawaii 96721-1027

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Nagata:

Thank you for your letter dated October 1, 2010. We appreciate HELCO's intent to provide electrical service for the proposed development and acknowledge that a detailed analysis will be performed by HELCO as the developer submits design drawings. The information you provided on HELCO's existing capacity and system is valuable and will be used in the planning and design of electrical service for the proposed project.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

EM

September 19,2010

Mr. Earl Matsukawa,AICP
Project Manager

RECEIVED
SEP 21 2010
WILSON OKAMOTO CORPORATION

Dear Mr. Matsukawa,

On behalf of the Kona Hawaiian Civic Club, I have received your EISPN for the proposed Kaloko Makai project. I will review it with the members of our club. Therefore ther will be a comment forthcoming.
Any further business matters should be addressed to

Cynthia Nazara,Pelekikena
Kona Hawaiian Civic Club
P.O. Box 4098
Kailua-Kona, Hi. 96745

Mahalo

Cynthia Nazara,Pelekikena
Kona Hawaiian Civic Club

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Ms. Cynthia Nazara, Pelekikena
Kona Hawaiian Civic Club
P.O. Box 4098
Kailua-Kona, HI 96745

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Ms. Nazara:

Thank you for your letter dated September 19, 2010. We look forward to receiving additional comments from the Kona Hawaiian Civil Club. The forthcoming Draft EIS will be sent to you for review and comment.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

William P. Kenoi
Mayor

William T. Takaba
Managing Director

County of Hawai'i
DEPARTMENT OF PUBLIC WORKS
Aupuni Center
101 Pauahi Street, Suite 7 · Hilo, Hawai'i 96720-4224
(808) 961-8321 · Fax (808) 961-8630
www.co.hawaii.hi.us

Warren H. W. Lee
Director

Brandon A. K. Gonzalez
Deputy Director

EM

January 5, 2011

RECEIVED
JAN 06 2011
WILSON OKAMOTO CORPORATION

Mr. Earl Matsukawa, AICP
Project Manager
Wilson Okamoto Corporation
1907 South Beretania Street
Honolulu, HI 96826

Subject: Environmental Assessment (EA) Environmental Impact Statement
Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, N. Kona, HI
TMK: (3) 7-3-009:017, 025, 026 and 028

We reviewed the subject EISPN dated September 2010 and have the following comments. With regard to connectivity and continuity, the General Plan (GP) and Kona Community Development Plan (KCDP) concept maps shall be implemented when practicable. However, there is a concern regarding the extension of Kamanu Street directly through Hina Lani at the existing location because of the grade. We request an engineering study be done to examine alternatives. The study should examine the alternatives on the basis of traffic safety, traffic flow efficiency and accommodation of all modes of transportation.

Full movement intersections on collector streets and arterials should be spaced to provide for proper signal timing. For collectors, minimum spacing should be ¼ mile and for arterials minimum spacing should be ½ mile. Roundabouts can provide more flexibility.

Ane Keohokalole Highway is classified and designed as a major collector road by the Federal Highway Administration and State of Hawaii Department of Transportation. Ane Keohokalole Highway is classified an arterial and Hina Lani Street and Kamanu Streets are classified as collectors on the County's GP and KCDP. The proposed intersection spacing shown on Figure 2.1 does not appear to meet the guidelines stated above.

If you have any questions, Please feel free to contact Kiran Emler of our Kona office at 327-3530.

Warren H.W. Lee, P.E.
Director

cc: Planning Director
Engineering, Hilo/Kona

County of Hawai'i is an Equal Opportunity Provider and Employer.

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7469-01
July 25, 2011

Mr. Warren H.W. Lee, P.E., Director
Department of Public Works
County of Hawaii
101 Pauahi Street, Suite 7
Hilo, HI 96720-4224

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Lee:

Thank you for you letter dated January 5, 2011 (2010-TA-0513). We offer the following responses in the respective order of your comments:

1. Kaloko Makai met with Mr. Ron Thiel and Mr. Kiran Emler to discuss proposed project, including the Kamanu Street Extension. Based on that consultation, adjustments were made on the Kaloko Makai land plan. Mr. Thiel and Mr. Emler's assistance on this matter is greatly appreciated.

   We acknowledge that the major roadway alignments shown on both the Kona Community Development Plan (CDP) and the Kaloko Makai land plan are presently conceptual and that further engineering and traffic analysis will be required to establish their final alignments.

2. We acknowledge that full movement intersections on collector streets and arterials should be spaced to provide for proper signal timing. Roadways will be designed to meet Hawaii County Code and Kona Community Development (CDP) Connectivity Standards (Policy TRAN-2.1). Alternative intersection configurations, such as roundabouts, will be considered during subsequent engineering and traffic analysis and design in consultation with your agency.

3. We acknowledge that Ane Keohokalole Highway is classified and designed as a major collector road by Federal Highway Administration and State of Hawaii Department of Transportation.

4. We acknowledge Ane Keohokalole Highway is classified as an arterial and Hina Lani Street and Kamanu Streets are classified as collectors according the County General Plan and Kona CDP. As a result of consultation with Mr. Thiel and Mr. Emler, the proposed intersection spacing was revised in the land plan to be included in the forthcoming Draft EIS.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME LEINAALA FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801

In reply, please refer to:
EMD / WB
LUD-3 7 3 009 017 etc-ID#509
EA EISPN Kaloko Makai

November 4, 2010

EM
TF

Mr. Earl Matsukawa, AICP
Project Manager
Wilson Okamoto Corporation
1907 South Beretania Street
Artesian Plaza Suite 400
Honolulu, Hawaii 96826

RECEIVED
NOV 0 5 2010
WILSON OKAMOTO CORPORATION

Dear Mr. Matsukawa:

Subject: Environmental Assessment / Environmental Impact Statement Preparation Notice
Kaloko Makai, Kaloko and Kaohanaiki, North Kona, Hawaii
TMK (3) 7-3-009: 017, 025, 026 and 028 1,142 acre master planned community

Thank you for allowing us the opportunity to review the subject project which proposes to develop Kaloko Makai, an approximately 1,142 acre master planned community in Kaloko and Kohaniki, North Kona, Hawaii. The subject project is located in the non-critical wastewater disposal area as determined by the Hawaii County Wastewater Advisory Committee.

The subject document stated that, "A PER will be prepared for the Draft EIS to determine the projected wastewater flow and explore associated facility requirements for the proposed project. It is anticipated that the project will likely construct a wastewater treatment plant." Please be informed that a wastewater treatment plant will be required to be constructed for this project in accordance with Hawaii Administrative Rules (HAR), Chapter 11-62 "Wastewater Systems."

We further encourage the developer to utilize recycled water for irrigation and other non-potable water purposes such as dust control, parks, golf courses, open spaces or landscaping areas. Further, any means to reduce green house gas emissions, practice renewable energy and a reduction in waste is highly recommended.

All wastewater plans must conform to applicable provisions of the Department of Health's HAR, Chapter 11-62 "Wastewater Systems." We do reserve the right to review the detailed wastewater plans for conformance to applicable rules. Should you have any questions, please contact the Planning & Design Section of the Wastewater Branch at 586-4294.

Sincerely,

MARSHALL LUM, P.E., ACTING CHIEF
Wastewater Branch

LM:lmj

c: DOH's Environmental Planning Office (EPO I-3345)
DOH-WWB's Kona Staff – Mr. Dane Hiromasa
SCD-TSA Kaloko Makai LLC

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS

1907 South Beretania Street
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FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Ms. Sina Pruder, P.E., Acting Chief
Wastewater Branch
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, HI 96801

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Ms. Pruder:

Thank you for your letter dates November 4, 2010 (EMD/WB LUD-3 7 3 009 017 etc-ID#509 EA EISPN Kaloko Makai). We offer the following responses in the respective order of your comments:

1. We appreciate your confirmation that the proposed project is located in the non-critical wastewater disposal area as determined by the Hawaii County Wastewater Advisory Committee.

2. We acknowledge that the proposed wastewater treatment plant will be required to be constructed in accordance with Hawaii Administrative Rules (HAR), Chapter 11-62 "Wastewater Systems."

3. The proposed wastewater treatment plant will produce reclaimed (R-1) quality water for general irrigation within Kaloko Makai, thus lessening the demand for potable water. Kaloko Makai will also implement feasible measures to promote energy conservation and environmental stewardship, such as the standards and guidelines promulgated by the US Green Building Council, US EPA Energy Star Program, and other similar programs.

4. We acknowledge that wastewater plans must conform to applicable provisions of the Department of Health's HAR, Chapter 11-62 "Wastewater Systems. We further acknowledge that you reserve the right to review detailed wastewater plans for conformance to applicable rules.

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

MICHAEL D. FORMBY
INTERIM DIRECTOR

Deputy Directors
FRANCIS PAUL KEENO
JIRO A. SUMADA

IN REPLY REFER TO:

STP 8.0269

October 26, 2010

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

NOV 03 2010

Dear Mr. Matsukawa:

Subject: SCD-TSA Kaloko Makai, LLC
Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)

The State Department of Transportation (DOT) previously commented on the subject case during the EISPN period in its letters STP 8.2966 dated August 12, 2008 and STP 8.2944 dated July 24, 2008 (attached).

The DOT Highways Division Planning Branch is still reviewing the subject project. Until this review is completed, DOT's prior comments remain valid.

DOT appreciates the opportunity to provide comments. If there are any other questions, including the need to meet with DOT Highways Division staff, please contact Mr. David Shimokawa of the DOT Statewide Transportation Planning Office at 831-7976.

Very truly yours,

Francis Paul Keeno
for MICHAEL D. FORMBY
Interim Director of Transportation

Attachments: STP ltr 8.2966 dtd 8/12/08
STP ltr 8.2944 dtd 7/24/08

c: Abbey Seth Mayer, Department of Business, Economic Development and Tourism – Office of Planning

---

LINDA LINGLE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

BRENNON T. MORIOKA
DIRECTOR

Deputy Directors
MICHAEL D. FORMBY
FRANCIS PAUL KEENO
BRIAN H. SEKIGUCHI

IN REPLY REFER TO:
DIR 0954 & 1027
STP 8.2944

July 24, 2008

TO: MR. ABBEY MAYER, DIRECTOR
OFFICE OF PLANNING
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT AND TOURISM

FROM: for BRENNON T. MORIOKA Francis Paul Keeno
DIRECTOR OF TRANSPORTATION

SUBJECT: SCD KALOKO MAKAI, LLC
KALOKO MAKAI
ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE (EISPN)

Thank you for requesting the Department of Transportation's (DOT) review of the subject development project as presented in the EISPN. The DOT submits the following initial comments:

1. The proposed 1,142-acre master-planned community, consisting of 5,000 residential units, retail and commercial uses, schools, parks, open space network, and supporting infrastructure will significantly impact two DOT highway facilities - Queen Kaahumanu Highway and Mamalahoa Highway.

2. The DOT understands that a Traffic Impact Analysis Report (TIAR) that analyzes traffic impacts on the roadway system within the project vicinity and identifies appropriate mitigation measures will be prepared for DOT review and approval. The DOT Highways Division is particularly interested in the project's cumulative traffic impacts and mitigation measures at and near the highway access points.

3. The DOT Highways Division is currently in discussions with various developments in the area regarding the construction of a full intersection at Queen Kaahumanu Highway and Hulikoa Drive. These discussions include the provisions necessary to preserve Queen Kaahumanu Highway as a high-speed, limited access route, with possible grade-separated connections. The subject project's development plan and TIAR should address these considerations.

4. Drainage flows and systems in or within close proximity of DOT properties require DOT's prior review and approval.

5. Assumptions on timetables for State highway projects should be updated. Section 3.17.4, Roadways System and Traffic states, "...Phase I of the Queen Kaahumanu Highway Expansion is anticipated to be completed by May 2008." The EISPN also states,"...Phase II of the Queen Kaahumanu Highway Expansion is proposed to be completed before the end of 2007." According to the DOT Highways Division, Phase I is scheduled for completion by December 2008 and Phase II is expected to be completed in 2011.

6. The Draft EIS should discuss the project relative to past, current and future land development projects and growth in the area.

7. The petitioner/applicant should consult with the DOT Highways Division Planning Branch regarding the above concerns.

8. The DOT is an interested party and requests at least four (4) copies of the forthcoming Draft EIS. The DOT defers further comment on the subject project, until its review of the Draft EIS.

The DOT appreciates the opportunity to provide its comments.

ET:km

c: Christopher Yuen, Hawaii Department of Planning
Mr. Alan Suwa, Wilson Okamoto Corporation

bc: HWY, -H, -P, -T
STP(ET)

LINDA LINGLE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

BRENNON T. MORIOKA
DIRECTOR

Deputy Directors
MICHAEL D. FORMBY
FRANCIS PAUL KEENO
BRIAN H. SEKIGUCHI

IN REPLY REFER TO:
DIR 0954 & 1027
STP 8.2966

August 12, 2008

TO: MR. ABBEY MAYER, DIRECTOR
OFFICE OF PLANNING
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT AND TOURISM

FROM: BRENNON T. MORIOKA
DIRECTOR OF TRANSPORTATION

SUBJECT: SCD KALOKO MAKAI, LLC
KALOKO MAKAI
ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE (EISPN)

The following comments are provided by the Department of Transportation (DOT) Highways Division to supplement DOT's letter, STP 8.2944, dated July 24, 2008, on the proposed subject development project:

1. DOT opposes the change in land use designation from Conservation to Urban on the portion of the site adjoining Queen Kaahumanu Highway that is proposed for commercial development. Based on DOT's long-range regional transportation requirements and preliminary engineering plans, a grade-separated interchange is proposed for the area between Hina Lani Street and Huliko'a Drive. DOT thus seeks the dedication of Right-of-Way (RoW) in this area for the grade-separated interchange as a condition of land use approval for the remainder of the proposed project area.

   It is DOT's policy to preserve the Queen Kaahumanu Highway corridor as a future, high-speed, access-controlled facility. This will allow the DOT to meet its long-term requirements for regional movement of people and goods. Access onto Queen Kaahumanu Highway would only be allowed through grade-separated interchanges. Direct access onto Queen Kaahumanu Highway from adjoining properties would be restricted.

   The petitioner for the proposed subject development should contact the DOT Highways Division, Planning Branch, regarding the specific location and dimensions of the RoW for the proposed grade-separated interchange.

2. The layout of the proposed subject development should be modified and based on the long-range plans for an access-controlled highway that includes a grade-separated interchange between Hina Lani Street and Huliko'a Drive. The TIAR for the proposed development, however, must also address the interim highway conditions that include an at-grade intersection at Hina Lani Street. It must also be noted that the Queen Kaahumanu Highway-Phase II project is currently proceeding through its procurement phase. This Design-Build project will widen Queen Kaahumanu Highway to a four-lane divided roadway between Kealakehe Parkway and the Keahole Airport Access Road, and includes improvements at the Hina Lani Street/Queen Kaahumanu Highway intersection.

3. Traffic generated by the proposed subject development is anticipated to significantly impact the Queen Kaahumanu Highway/Hina Lani Street intersection as well as the Hina Lani Street/Mamalahoa Highway/Palani Road intersection. The petitioner must properly mitigate all anticipated project-generated impacts and properly coordinate the timely implementation of these mitigation measures with the DOT Highways Division. The petitioner should also be required to pay for a fair share of the regional transportation improvements.

4. The proposed subject development should be consistent with the County of Hawaii's Kona Community Development Plan (CDP) that includes: a comprehensive regional transportation system of both parallel north-south roads and mauka-makai roads; a major mid-level road that would serve as a trunk transit route; connectivity between adjoining developments; and concurrency on the timing of developments to avoid overloading the regional arterial transportation system.

The DOT appreciates the opportunity to provide these supplemental comments.

ET/GS:km

c: Christopher Yuen, Hawaii Planning Department
Alan Suwa, Wilson Okamoto, Inc.

bc: HWY, -H, -P (PS 08-238), -T, STP(ET)

NEIL ABERCROMBIE
GOVERNOR

JEFFREY CHANG
ACTING DIRECTOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO
STP 8.0302

December 8, 2010

RECEIVED
DEC 14 2010
WILSON OKAMOTO CORPORATION

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

Dear Mr. Matsukawa:

Subject: SCD-TSA Kaloko Makai, LLC
Environmental Assessment (EA)/Environmental Impact Statement
Preparation Notice (EISPN)

The State Department of Transportation (DOT) previously commented on the EA/EISPN for the subject project in its letter STP 8.0269 dated October 26, 2010, (attached) and offers the following supplemental Highways comments regarding the Traffic Impact Analysis Report (TIAR):

1. The TIAR needs to include supporting documentation regarding the assumptions used in its preparation, estimates of contributory traffic impacts from developments likely to contribute materially to background traffic increases and the basis for any "without project" roadway system improvements that are to be done by others.

2. The TIAR should address the future right-of-way requirements for a grade-separated interchange, and the provisions for a compatible roadway and connecting roadways (i.e. a frontage road) to avoid delaying this roadway upgrade.

3. The TIAR should also provide a description of the basis used in arriving at the costs applied in determining the developer's fair share contribution towards regional roadway improvements.

DOT appreciates the opportunity to provide supplemental comments on the subject project. When the DEIS for the project is completed, DOT requests that at least four (4) hard, paper copies of the document in addition to electronic media (i.e. CD-ROM) be provided. If there are any questions, including the need to meet with Highways Division staff, please contact

STP 8.0302

Mr. David Shimokawa of the DOT Statewide Transportation Planning Office at telephone number (808) 831-7976.

Very truly yours,

JEFFREY CHANG
Acting Director of Transportation

Attachment: Ltr STP 8.0269 dtd 10/26/10

LINDA LINGLE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

MICHAEL D. FORMBY
INTERIM DIRECTOR

Deputy Directors
FRANCIS PAUL KEENO
JIRO A. SUMADA

IN REPLY REFER TO

STP 8.0269

October 26, 2010

Mr. Earl Matsukawa
Wilson Okamoto Corporation
1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826

Dear Mr. Matsukawa:

Subject: SCD-TSA Kaloko Makai, LLC
Environmental Assessment (EA)/Environmental Impact Statement
Preparation Notice (EISPN)

The State Department of Transportation (DOT) previously commented on the subject case during the EISPN period in its letters STP 8.2966 dated August 12, 2008 and STP 8.2944 dated July 24, 2008 (attached).

The DOT Highways Division Planning Branch is still reviewing the subject project. Until this review is completed, DOT's prior comments remain valid.

DOT appreciates the opportunity to provide comments. If there are any other questions, including the need to meet with DOT Highways Division staff, please contact Mr. David Shimokawa of the DOT Statewide Transportation Planning Office at 831-7976.

Very truly yours,

for MICHAEL D. FORMBY
Interim Director of Transportation

Attachments: STP ltr 8.2966 dtd 8/12/08
STP ltr 8.2944 dtd 7/24/08

c: Abbey Seth Mayer, Department of Business, Economic Development and Tourism – Office of Planning

7469-01
July 25, 2011

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
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FAX: 808-946-2253
www.wilsonokamoto.com

Mr. Glenn Okimoto, Director
Department of Transportation
State of Hawaii
869 Punchbowl Street
Honolulu, HI 96813-5097

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Okimoto:

Thank you for your letters dated October 26, 2010 (STP 8.0269) and December 8, 2010 (STP 8.0302). Your October 26, 2010 letter also states that comments offered in your letter dated July 24, 2008 on the previous EISPN published for the project remain valid. We offer the following responses in the respective order of your comment letters.

July 24, 2008 (DIR 0954 & 1027, STP 8.2944)

1. We acknowledge that the proposed project may significantly impact DOT Highway Facilities – Queen Kaahumanu Highway and Mamalahoa Highway. The Draft EIS will include a Traffic Impact Assessment Report (TIAR) that will address access and traffic issues, as well as recommend mitigation measures to address potential adverse impacts.

2. As mentioned above, the Draft EIS will include a TIAR, which will also address cumulative impacts.

3. Intersection improvements at Hulikoa and Queen Kaahumanu Highway have been implemented. We acknowledge DOT's policy to preserve Queen Kaahumanu corridor as a future, high-speed, access-controlled facility. The proposed project is not proposing direct access to Queen Kaahumanu.

4. We acknowledge that any modification of drainage systems in or within close proximity to DOT properties require your review and approval.

5. Notably, we understand that Phase 1 of the Queen Kaahumanu Highway has been completed and Phase 2 from Kealakehe Parkway to Keahole Airport Access Road is underway. The updated information on DOT project schedule is appreciated. We will incorporate this information, as well as any subsequent updates in our TIAR and Draft EIS.

6. The Draft EIS will discuss current and future land development projects in the vicinity of the project site.

7. Kaloko Makai will consult with DOT Highways Division, Planning Branch regarding the preceding information.

8. We will provide four copies of the forthcoming Draft EIS to DOT.

August 12, 2008 Letter (DIR 0954 & 1027, STP 8.2966)

1. We understand that the State of Hawaii Department of Transportation's (DOT) opposition to the change in land use designation from Conservation to Urban on the portion of the site adjoining Queen Kaahumanu Highway. Use of this area for an interchange, however, is more consistent with Urban designation than Conservation. We acknowledge DOT's long-range transportation plan for a proposed grade-separated interchange at this location. Any proposed interior use of this area by Kaloko Makai, such as for light-industrial and mixed-use would be subject to removal when DOT is ready to construct the interchange.

2. The land plan in the forthcoming Draft EIS will indicate the location of DOT's planned interchange. The TIAR will consider the current at-grade conditions, as well as plans for intersection improvements at the Hina Lani Street intersection associated with the on-going Queen Kaahumanu Highway Widening Project.

3. The TIAR will recommend mitigation measures to address traffic impacts associated with Kaloko Makai. These mitigation measures and Kaloko Makai's fair share cost responsibilities will be the subject of future consultation with DOT, Highways Division, Planning Branch.

4. The project will be consistent with the County's Kona Community Development Plan, including provision for transportation improvements and concurrency, as will be discussed in the forthcoming Draft EIS.

December 8, 2010 (STP 8.0302)

1. The TIAR will include supporting documentation regarding the assumptions used in preparing estimates of contributory traffic impacts from developments likely to contribute materially to background traffic increases and the basis for any "without project" roadway system improvements that are to be done by others.

2. As discussed above, in recognition of DOT's planned grade-separated interchange planned for the area, the proposed light-industrial and mixed-use is subject to removal when DOT is ready to construct the interchange.

3. Kaloko Makai acknowledges that the project would be required to contribute a fair share portion of the cost for constructing transportation improvements, however, it is premature to speculate on what the contribution should be at this conceptual planning stage.

9. We will provide four copies and a CD with pdf file of the forthcoming Draft EIS to DOT.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801-3378

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
File:

October 25, 2010

TO: Mr. Earl Matsukawa, AICP
Wilson Okamoto Corporation

FROM: Russell S. Takata, Program Manager
Indoor and Radiological Health Branch

SUBJECT: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026 & 028

Our comments should be printed as follows:

"Project activities shall comply with the Administrative Rules of the Department of Health:

- Chapter 11-46 Community Noise Control.

Should there be any questions, please contact me at 586-4701.

WILSON OKAMOTO CORPORATION
ENGINEERS | PLANNERS | CONSULTANTS
1907 South Beretania Street
Artesian Plaza, Suite 400
Honolulu, Hawaii, 96826 USA
Phone: 808-946-2277
FAX: 808-946-2253
www.wilsonokamoto.com

7469-01
July 25, 2011

Mr. Russell Takata, Program Manager
Indoor and Radiological Health Branch
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, HI 96801-3378

Subject: Environmental Assessment (EA)/Environmental Impact Statement Preparation Notice (EISPN)
Kaloko Makai
Kaloko and Kohanaiki, North Kona, Hawaii
Tax Map Key: (3) 7-3-09: 017, 025, 026, and 028

Dear Mr. Takata:

Thank you for you letter dated October 25, 2010. The proposed project will comply with Hawaii Administrative Rules (HAR), Chapter 11-46 "Community Noise Control." The Draft EIS will also include a Noise Study that will address potential short-term and long-term noise impacts generated by the project.

We appreciate your participation in the environmental review process.

Sincerely,

Earl Matsukawa, AICP
Project Manager

cc: Mr. Peter Phillips, Stanford Carr Development
Mr. Orlando Dan Davidson, State Land Use Commission

1907 S BERETANIA STREET, SUITE 400
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wilsonokamoto.com