3. DESCRIPTION OF THE NATURAL ENVIRONMENT, POTENTIAL IMPACTS AND MITIGATION MEASURES

This section describes the natural environment, potential impacts and mitigation measures associated with the Kaloko Makai development project.

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”, 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 landmasses 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 move 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 (4 to 16 miles per hour). Relative humidity is generally stable year-round, with the daily average ranging from 71 to 77 percent.

POTENTIAL IMPACTS AND MITIGATION MEASURES

No significant impact to the region’s climate is anticipated, however, replacing the sparsely vegetated area with an urban landscape will alter the microclimate of the site. The proposed project will help offset the loss of vegetation by providing irrigated parks, open space, landscaped areas and the approximately 150-acre Kaloko Makai Dryland Forest Preserve, but will result in a significant change in land cover, replacing vegetation with impervious surfaces.

The 150-acres Kaloko Makai Dryland Forest Preserve contains the best habitat for reproduction of native species and is one of the last remaining Dryland Forest ecosystems on the island. Approximately 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 approximately 150-acres is the single most important step in preserving the Dryland Forest ecosystem at Kaloko Makai. Through safeguarding this ecosystem, Kaloko Makai is ensuring that the Kaloko Makai Dryland Forest will flourish for generations to come.

3.2. GEOLOGY AND TOPOGRAPHY

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 percent, 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 percent) 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.

The project site occupies an area of slope, ranging from 5 to 8 percent. 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 710 feet above MSL. The site has a generally irregular surface with localized mounds and depressions throughout, as is characteristic of non-eroded lava flows.

POTENTIAL IMPACTS AND MITIGATION MEASURES

Construction of the proposed development will involve grading, excavating and trenching of presently undeveloped areas within the project site. The project will require alteration of existing landforms to create more efficient land development areas. Appropriate engineering, design and construction measures will be utilized to minimize potential soil erosion during construction.

Mass grading of the development areas will comply with the County of Hawaiʻi's grading ordinance requirements and will require a National Pollutant Discharge Elimination System (NPDES) permit from the State Department of Health (DOH) for storm water discharges associated with construction activities, including Best Management Practices (BMPs) to minimize off-site impacts.

3.3. SOILS

Three soil studies describe the soil structure of the area. They are the USDA Soil Conservation Service Soil Survey, the Land Study Bureau's Detailed Land Classification and the State Department of Agriculture's Agricultural Lands of Importance to the State of Hawaiʻi.

3.3.1. USDA Soil Conservation Service Soil Survey

The U.S. Department of Agriculture Natural Resources Conservation Service's (NRCS) *Soil Survey of the Island of Hawaiʻi, State of Hawaiʻi*, classifies the soil in the project site as pāhoehoe lava flows (rLW), ʻaʻā lava flows (rLV), Kaimu extremely stone peat (rKED), and Punaluʻu extremely rocky peat (rPYD). Descriptions of the soil classifications are as follows (see Figure 3-1):

Lava Flows, pāhoehoe (rLW) – Lava flows are considered "miscellaneous land types." Pāhoehoe lava has no soil cover and is virtually devoid of vegetation, except for mosses and lichens. Pāhoehoe lava, which occurs over approximately 21 percent 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.

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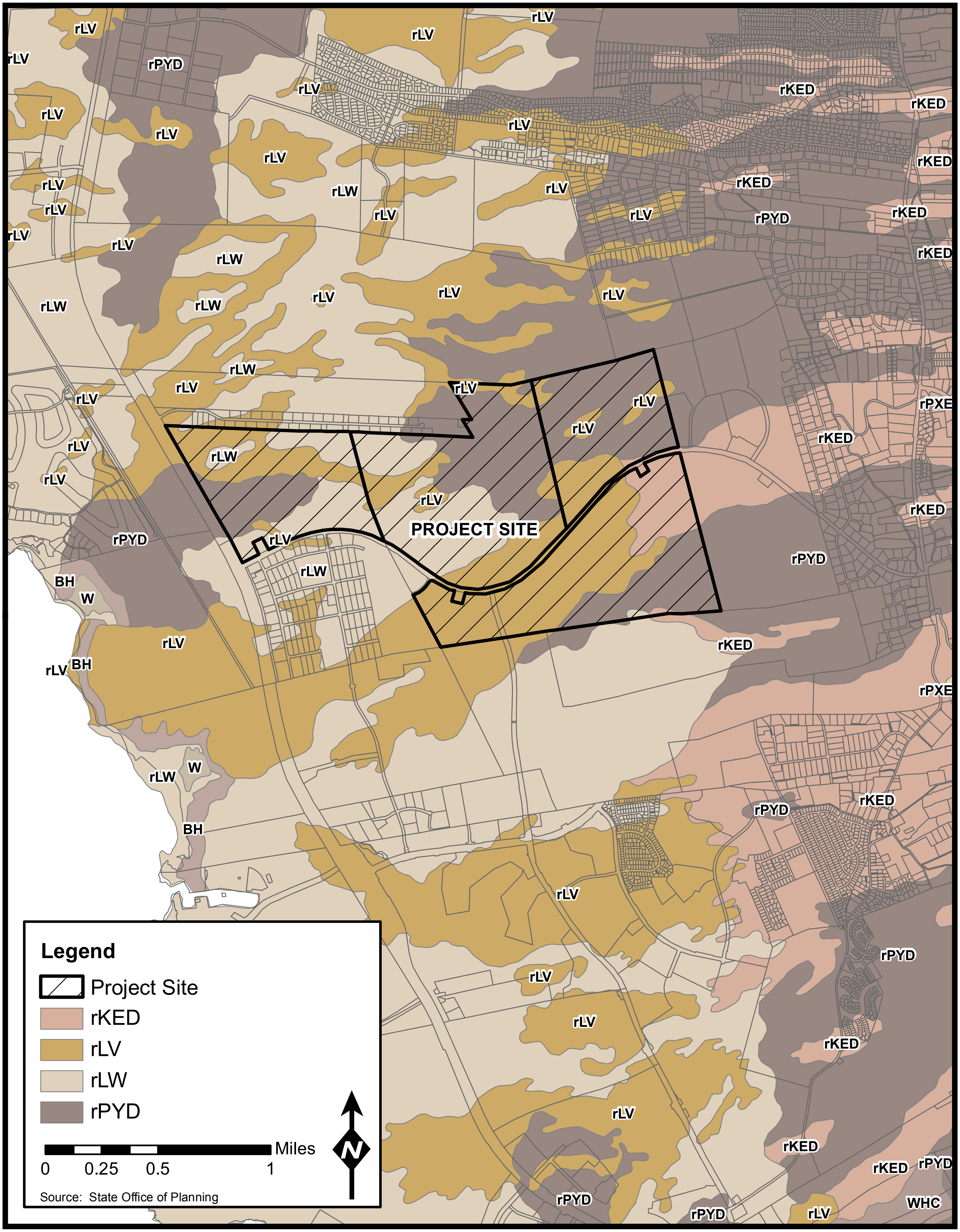

FIGURE 3-1
Soils Map
Kaloko Makai

The Soil Conservation Service's Land Capability Grouping is a system of grouping soils primarily based on their capability to produce common cultivated crops and pasture plants without deteriorating over an extended time frame. The system groups soil from I, the highest level to VIII the lowest level. The soil capability class rating for 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.

Lava Flows, ʻaʻā (rLV) – Lava flows are considered "miscellaneous land types." ʻAʻā lava has little soil cover and is virtually devoid of vegetation, except for within the Kaloko Makai Dryland Forest where ecological succession has lead to the development of a Dryland Forest ecosystem upon the ʻaʻā lava flow. Approximately 37 percent of the site consists of aʻā lava, which is characterized by clinkery, hard, glassy pieces piled in tumbling heaps.

The soil capability class rating for ʻaʻā 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.

Kaimu, extremely stone peat (rKED) - Approximately 6 percent of the project site consists of Kaimū soils (Kaimū extremely stony peat, 6 to 20 percent slope.) These soils are comprised of very dark brown extremely stony peat about 3 inches thick. It is underlain by fragmental ʻaʻā lava. This soil is neutral in reaction.

This soil is not suitable for cultivation. These soils are rated Class VIIs, non-irrigated. The sub-classification "s" indicates that the soils are extremely rocky or stony.

Punaluʻu, extremely rocky peat (rPYD) - Approximately 36 percent of the project site consists of Punaluʻu soils (Punaluʻu extremely rocky peat, 6 to 20 percent slope.) These soils are comprised of rock outcrops over 40 to 50 percent of the surface, and medium-acid peat about 4 inches thick underlain by pāhoehoe lava bedrock.

The site consists of lands classified as very poorly suited for agricultural productivity. 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. The sub-classification "s" indicates that the soils are extremely rocky or stony.

3.3.2. LSB Detailed Land Classification

The *Detailed Land Classification - Island of Hawaiʻi* prepared by the University of Hawaiʻi 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.

According to the LSB, the Petition Area is very poorly suited for agricultural productivity. Approximately 73 percent of the project area is rated E, the lowest productivity rating, approximately 9 percent is rated D, and the remaining is unclassified (see Figure 3-2).

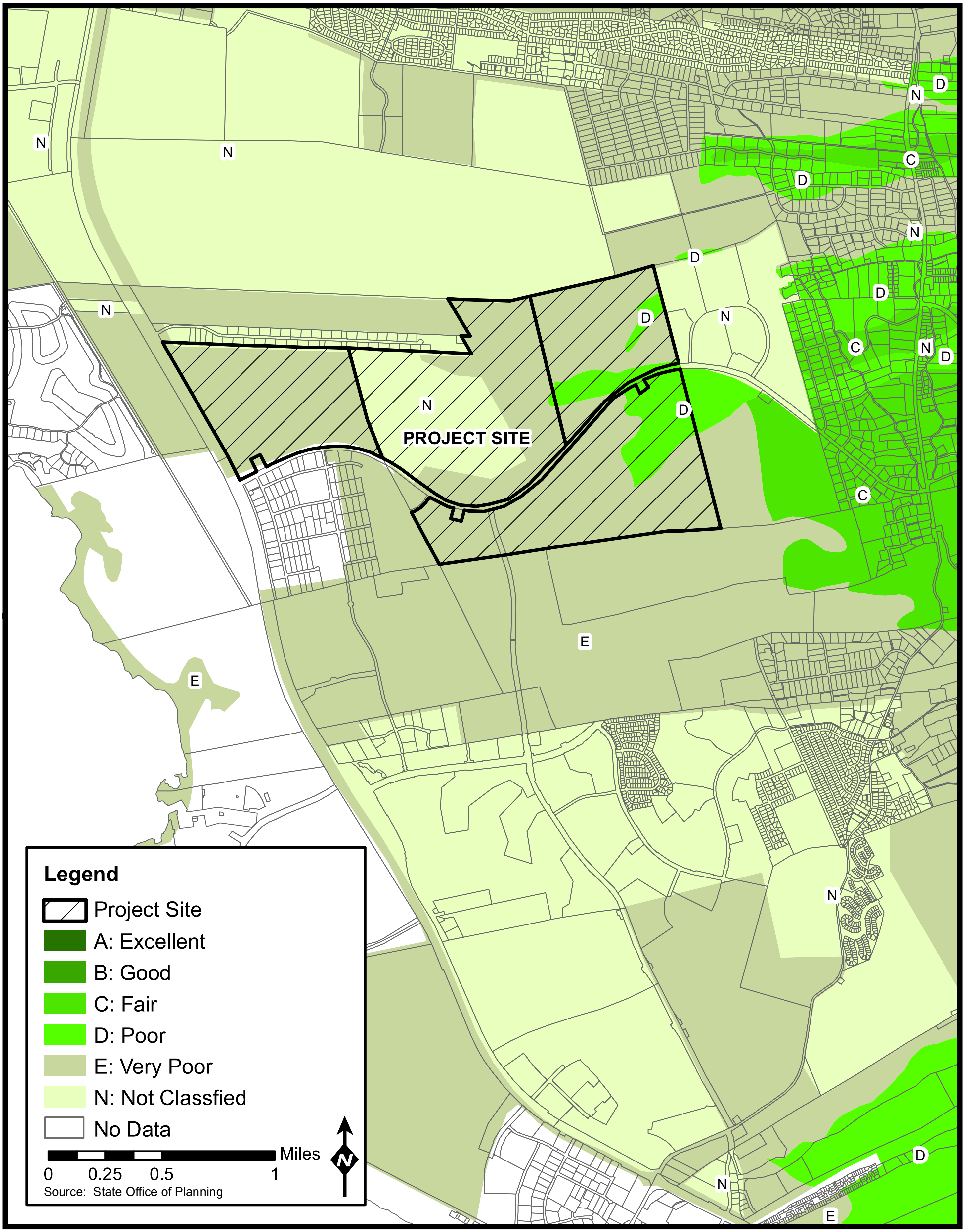

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FIGURE 3-2
Land Study Bureau Map
Kaloko Makai

3.3.3. Agricultural Land of Importance to the State of Hawaiʻi

The Agricultural Lands of Importance in the State of Hawaiʻi (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. It includes soils with the best physical, chemical and climatic properties for mechanized field crops;
2) Unique Agricultural Land, which is land other than Prime agricultural land used for the production of unique high-value crops (coffee, taro, watercress, etc); and
3) Other Important Agricultural Land, which is comprised of State or local important lands for production, not prime or unique; needing irrigation or requiring commercial production management.

None of the land within the Petition Area is identified as "Prime" or "Unique" Agricultural Lands under the ALISH system. Approximately 6 percent of the project site is designated “Other”, and the remainder of the project site is not classified in the ALISH system, thus, not considered important agricultural lands (see Figure 3-3).

POTENTIAL IMPACTS AND MITIGATION MEASURES

The soil class ratings for the property of Class VIIs and Class VIII mean that the soils are not suitable for cultivation and use is generally restricted to non-agricultural use. Additionally, the project area is rated D, E and unclassified by the LSB Detailed Land Classification.

With only 6 percent of the project site designated “Other” and the remainder of the project site not classified in the ALISH system, Kaloko Makai will not have an impact on agriculturally significant lands and will not reduce the inventory of agricultural significant lands. There are no significant existing or planned agricultural activities on the State Agricultural District lands adjoining or in close proximity to Kaloko Makai.

Construction of the proposed development will involve grading, excavation and trenching of presently undeveloped areas within the project site. The project will require alteration of existing landforms to create more efficient land development areas.

Appropriate engineering, design and construction measures will be undertaken to minimize potential erosion of soils during construction.

Mitigation measures will be instituted following site-specific assessments, incorporating structural and non-structural BMPs such as minimizing soil exposure and implementing erosion control measures such as silt fences and sediment basins. Following construction, erosion is anticipated to decrease since the soils will have been graded, built over, paved over or landscaped. Landscaping in turn will provide erosion control.

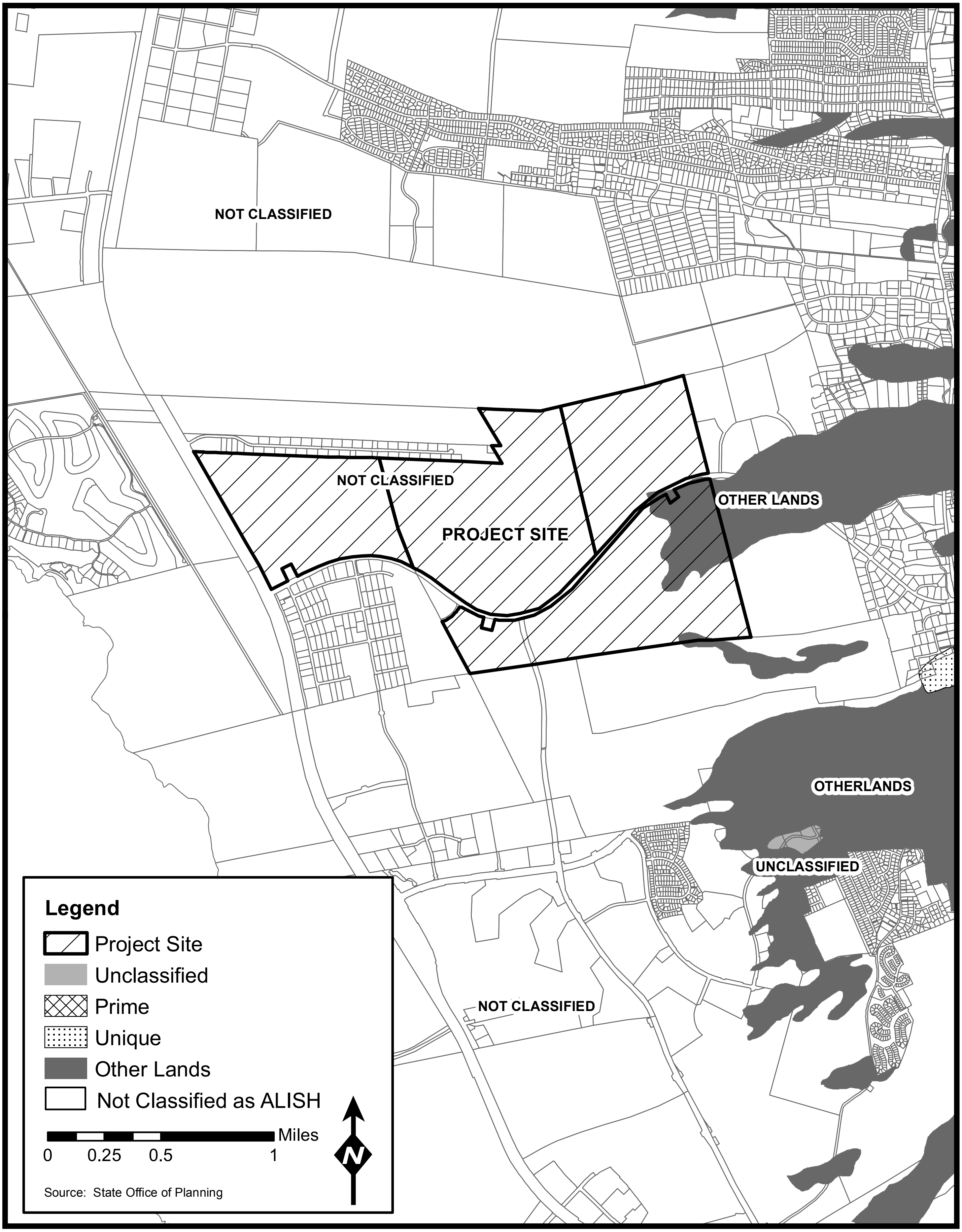

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FIGURE 3-3
Agricultural Lands of Importance in the State of Hawaii
Kaloko Makai

Mass grading of the development areas will be in compliance with the County of Hawaiʻi's grading ordinance requirements and will require NPDES permit from the State DOH for storm water discharges associated with construction activities, including BMPs to minimize off-site impacts.

3.4. NATURAL HAZARDS

3.4.1. Flooding

The FIRM identifies the project site as lying within Zone X, areas determined to be outside the 0.2% annual chance flood plain (Community Panel 1551660684C and 1551660703C revised April 2, 2004, panels not printed) (see Figure 3-4).

POTENTIAL IMPACTS AND MITIGATION MEASURES

The site is also not subject to a disproportionately greater likelihood of floods resulting from heavy rainstorms due to the highly porous nature of the existing lava substrate, which dominates its landscape.

Construction of the proposed project is not anticipated to result in flooding of the project site or lower elevation properties.

Kaloko Makai will be consistent with the Kona CDP Policy PUB–4.7: Urban Stormwater Management, by developing a Stormwater Management Program and Stormwater Management Guidelines that will regulate development and establish standards for public projects. The evolution of this program shall consider the following:

- *(a) a connected hierarchical overflow system where overflows from 10-year storm facilities (e.g., drywells) are directed to higher-capacity flood management systems, so that the total system can safely accommodate a 100-year storm;*
- *(b) use of natural drainageways and retention areas to the extent possible to maximize infiltration (groundwater recharge), filtration, and settling;*
- *(c) multi-purpose use of the higher-capacity (e.g., 25-year, 50-year, 100-year) flood management facilities for recreation or other uses since these areas will flood infrequently;*
- *(d) engineered "natural" flow ways to direct the sheetflow runoff into more defined drainageways;*
- *(e) onsite retention measures, such as rainwater harvesting methods;*
- *(f) street standards that minimize runoff and transport of sediment and contaminants;*
- *(g) watershed management system perspective;*
- *(h) Based on the Stormwater Management Program, existing and proposed Stormwater management flow ways and facilities shall be shown on the Official Public Facilities and Services Map, especially those maintained by the County.*

No maps were found in the Kona CDP that indicate any flood ways or facilities anywhere near the Kaloko Makai project.

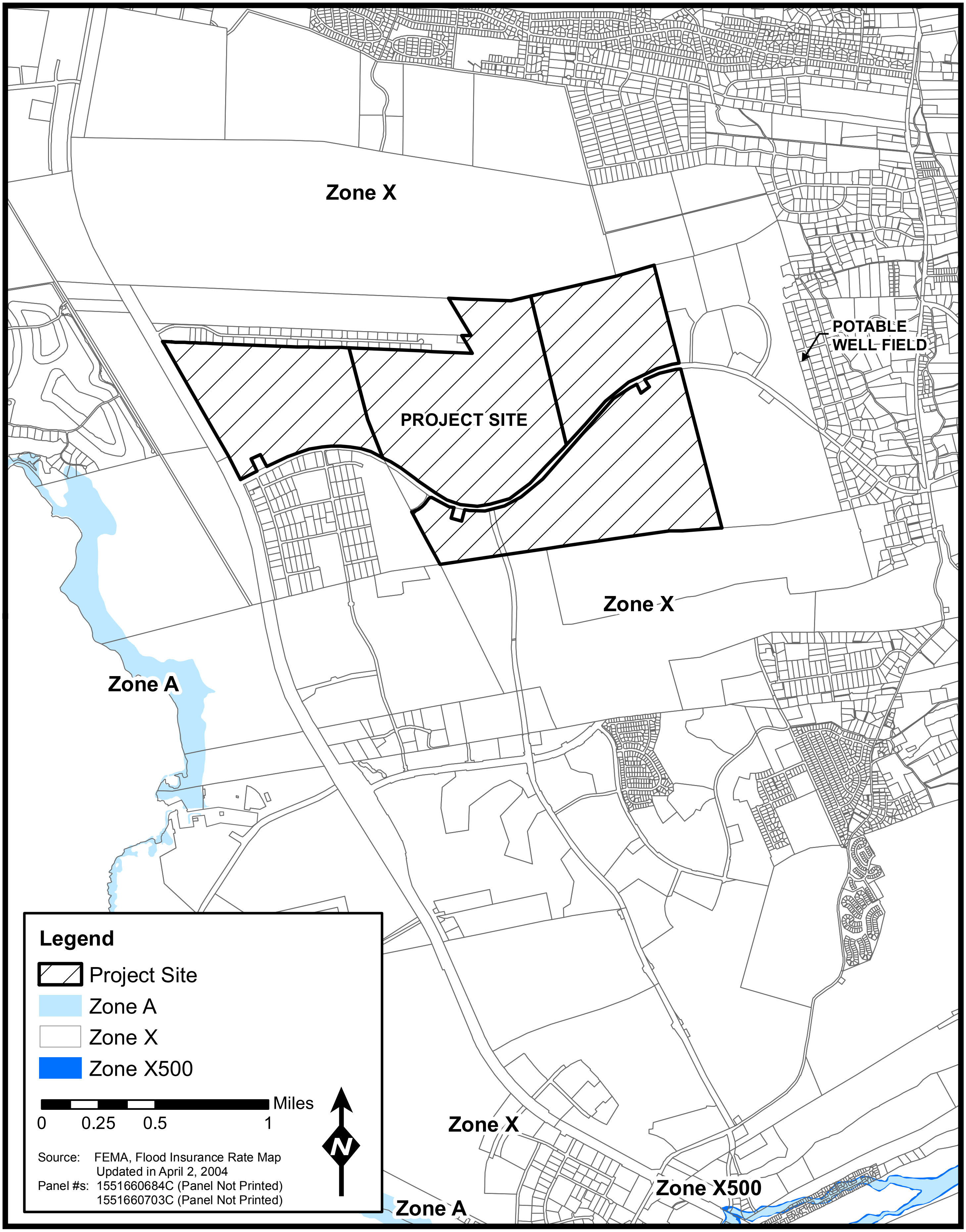

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FIGURE 3-4
Flood Zone Map
Kaloko Makai

3.4.2. Tsunami

The Island and County of Hawaiʻi has experienced four tsunamis since 1940. Because of its elevation and distance from the shore, the project site is not subject to tsunami inundation and is not within the Hawaiʻi County Civil Defense Agency's designated tsunami evacuation zone.

Kaloko Makai is located outside of the tsunami evacuation zone (Hawaii County Civil Defense Tsunami Evacuation Zone Maps, accessed website June 18, 2013, http://records.co.hawaii.hi.us/Weblink8/Browse.aspx?startid=24604&dbid=1)

Emergency shelters are located at Kealakehe High, Elementary and Intermediate Schools.

The County has 68 sirens and 12 simulators in operation around the island. Simulators provide a signal to manned stations where personnel are utilized to disperse the warning. Sirens have an effective average range of one-half mile (County of Hawaii Multi-Hazard Mitigation Plan, August 16, 2010).

POTENTIAL IMPACTS AND MITIGATION MEASURES

As the project site is not subject to tsunami inundation and is not within designated tsunami evacuation zones, schools built within Kaloko Makai can serve as shelters for those evacuating from lower elevations.

Further, the project's proximity to Queen Kaʻahumanu Highway, an identified evacuation route, makes the project site accessible for those evacuating from the coast.

3.4.3. Hurricane

The island of Hawaiʻi is exposed to hurricanes as result of its unique, varied topographic features and orientation. The island's landscape is dominated by five mountains, facilitating complex hurricane wind acceleration patterns. According to the *County of Hawaiʻi Multi-Hazard Mitigation Plan* (February 2005), eight hurricanes have affected the Hawaiian Islands and 12 others have posed a threat, since 1950.

Besides hurricanes, high winds from winter storms also can cause damage. The National Weather Service (NWS) defines a high wind event as sustained winds or frequent gusts of 40 miles per hour (mpg) or greater. For the County of Hawaiʻi, 28 events were identified during the period of January 1992 through October 2002 (County of Hawaiʻi, 2005).

POTENTIAL IMPACTS AND MITIGATION MEASURES

The International Building Code (IBC), 2006 Edition prepared by the International Code Council has been adopted and referenced in the Hawaiʻi County Code. All structures will be constructed in compliance with requirements of the IBC and other County, State and Federal standards.

3.4.4. Volcanic

The U. S. Geological Survey determines volcanic hazard maps. The zones are ranked from 1 through 9 based on the probability of coverage by lava flows, with Zone 1 being the highest hazard and Zone 9 being the lowest.

The Project is located in Zone 4. The lava flow hazard for Zone 4 is attributed to Hualālai, one of three volcanoes that have been active in historic times on the Island of Hawaiʻi. About 5 percent of the area within Zone 4 was covered by lava since 1800, and less than 15 percent of the area was covered by lava in the last 750 years. In this zone, the frequency of eruptions is lower than Kilauea and Mauna Loa, but flows typically cover large areas.

POTENTIAL IMPACTS AND MITIGATION MEASURES

The Hawaiʻi County Code relating to the International Building Code (IBC) does not address lava flows, however measures to address potential risks, such as developing emergency evacuation procedures, will be devised by the homeowners association, individual retail and commercial businesses within the project area.

3.4.5. Earthquake

The Island of Hawaiʻi is susceptible to seismic activities originating in fault zones under and adjacent to it. Two fault zones have been identified in the Kona region, the Kealakekua and Kaloko faults, both located in South Kona.

The IBC proposed rating system is based on a scale of 1 to 4, with a rating of 4 having the highest risk associated with seismic activity. The Hawaiʻi County Building Code requires that all new structures be designed to resist forces to seismic Zone 4 standards.

The IBC recommends that the Island of Hawaiʻi meet the IBC standards for Seismic Zone 4, as well.

Structures designed under this code must resist seismic design loads based on the seismic importance factor, seismic use group, mapped structural response accelerations, Ss and S1, seismic design category, and other factors corresponding to the specific location and characteristics of the building under consideration.

POTENTIAL IMPACTS AND MITIGATION MEASURES

In accordance with the Hawaiʻi County Code, all permanent structures will be designed to resist forces to seismic Zone 4 standards.

3.4.6. Wildfires

A majority of the subject property is dominated by Leucaena Scrub, Christmas Berry Scrub, Koa Haole and various grasses. This type of vegetation can be extremely flammable and susceptible to wildfire. Additionally the Kaloko Makai Dryland Forest is comprised of flammable vegetation.

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 Hawaiʻi. Native shrubland and Dryland Forests 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.

Fires may result from natural causes or they may be accidentally or purposely set by humans.

POTENTIAL IMPACTS AND MITIGATION MEASURES

The Kaloko Makai development will reduce the probability of wildfires on site by replacing vegetation with buildings, structures and appropriate landscaping. Landscaping will incorporate native species and appropriate vegetation for the area.

Since the Kaloko Makai 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 to act as a barrier if fire was to occur.

Additionally, appropriate signage will be developed to encourage public cooperation and discourage trespassing, vandalism and 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.

To further support firefighting efforts, Kaloko Makai may install a helicopter dip tank within the Kaloko Makai Dryland Forest Preserve in the previously graded portion of land within the Preserve.

Kaloko Makai will also contain complete 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.

3.5. GROUNDWATER RESOURCES AND NEARSHORE MARINE ENVIRONMENT

3.5.1. Groundwater Resources

Tom Nance Water Resources Engineering (TNWRE) prepared an *Assessment of the Potential Impact of the Proposed Kaloko Makai Project on Water Resources* (July 2013). A summary of the report is provided below and the report in its entirety is included in Appendix C.

The project site overlies the Keauhou Groundwater Aquifer System within the Hualālai aquifer sector (see Figure 3-5). Groundwater in North Kona occurs in two different modes: ground water occurs as a thin basal lens and as high-level groundwater. Location of wells within or near Kaloko Makai Project Site is shown in Figure 3-6.

<u>Basal Groundwater:</u> 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.

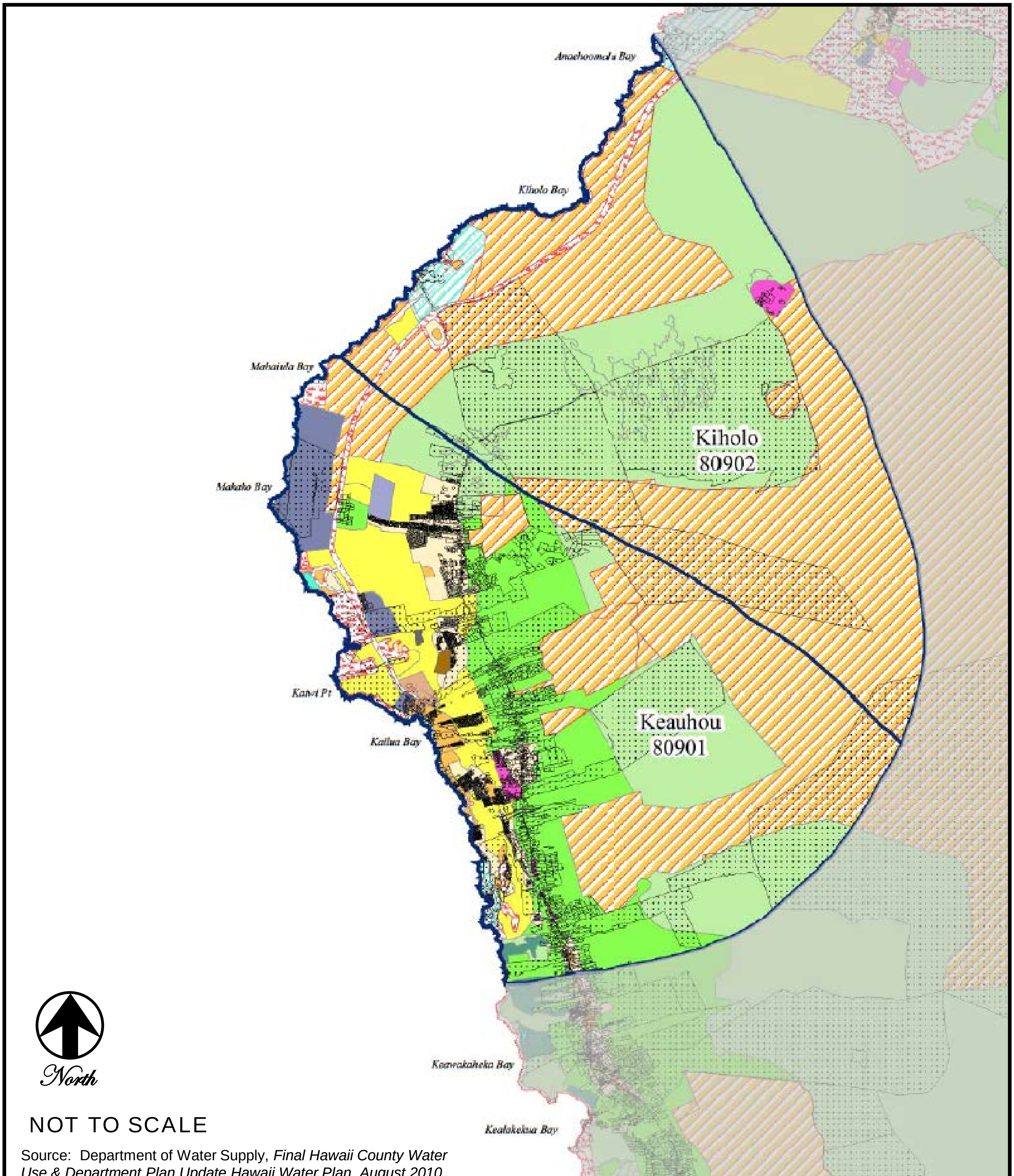
In the Keahole to Kailua area of North Kona, which includes the Project Site, the basal groundwater levels near the shoreline are about one foot above sea level and slowly increase moving inland to between two and three feet above sea level at the mauka end of the Project Site. The thin basal lens is influenced by ocean tides, an indication of the substantial permeability of the volcanic ash in which the groundwater resides.

Figure 3-7 illustrates a salinity and temperature profile through the water column of on-site Well 4160-02. The profile shows two irregular characteristics of the underlying basal groundwater given the extent of the potentially contributing upland watershed:

- The 65.8° F temperature at the top of basal lens is four to six degrees colder than in upgradient wells which tap the high level groundwater.
- The salinity is substantially higher than would otherwise be expected.

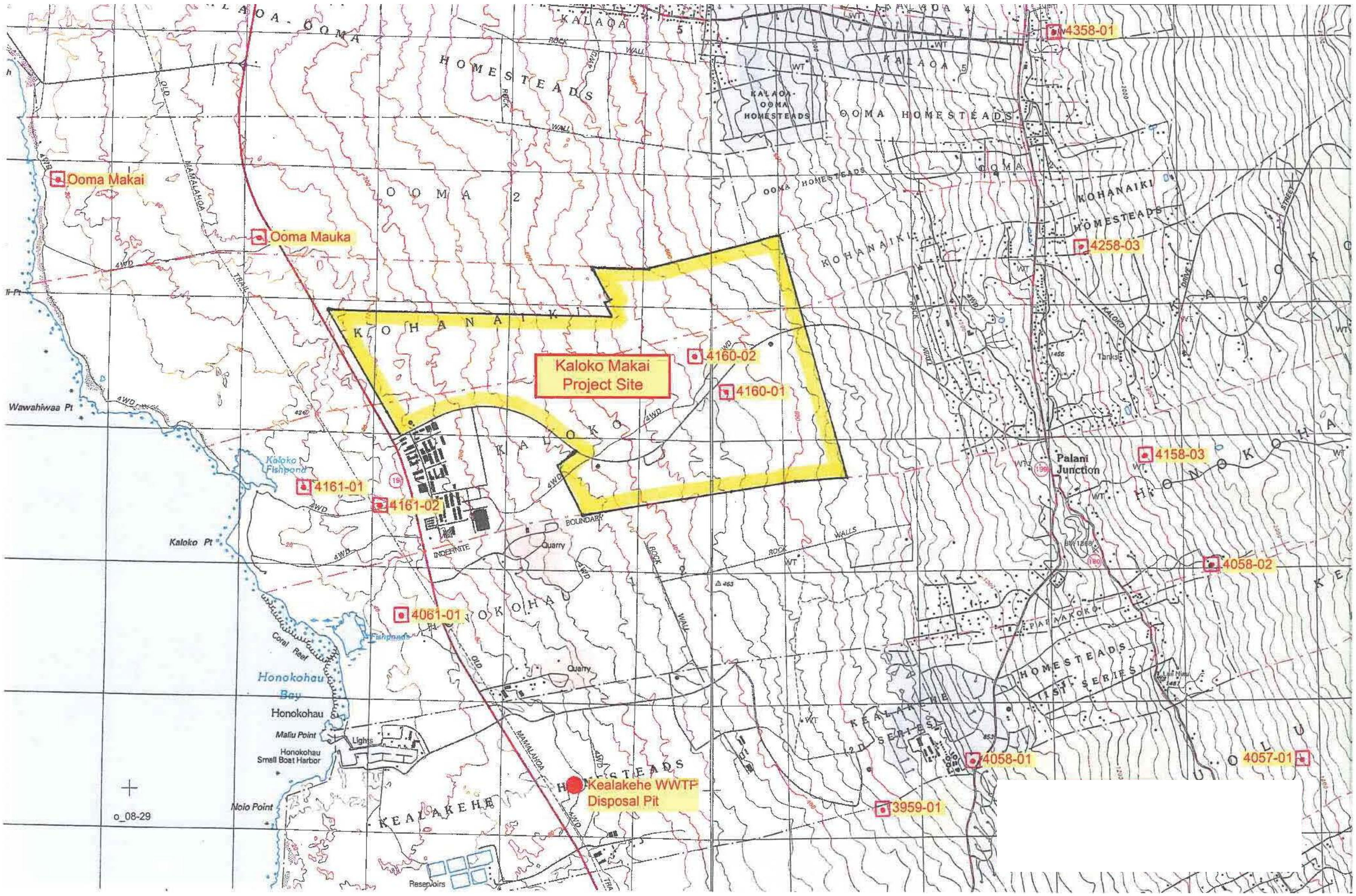
These characteristics are found in all basal wells from Keahole Point to as far south as the old Kona Airport.

<u>Flowrate Through Basal Aquifer:</u> The most recent and reliable computations of groundwater recharge for Hawai'i Island are presented in Engott, 2011. Kaloko Makai is part of the Keauhou Aquifer System. Engott computed a recharge of 152 million gallons per day (mgd). Reducing this by 14 mgd, the current groundwater pumpage from the aquifer system, leaves an average groundwater flow rate of about 9 mgd per coastal mile across the aquifer's shoreline width. If all the rainfall recharge into the high-level aquifer were to discharge into the down gradient basal lens, the flowrate would create a robust basal groundwater body which could be developed for irrigation use and possibly drinking water supply.



Source: Department of Water Supply, *Final Hawaii County Water Use & Department Plan Update Hawaii Water Plan, August 2010*

FIGURE 3-5
Hualalai Aquifer
Kaloko Makai



Source: Tom Nance Water Resource Engineering, December 2012

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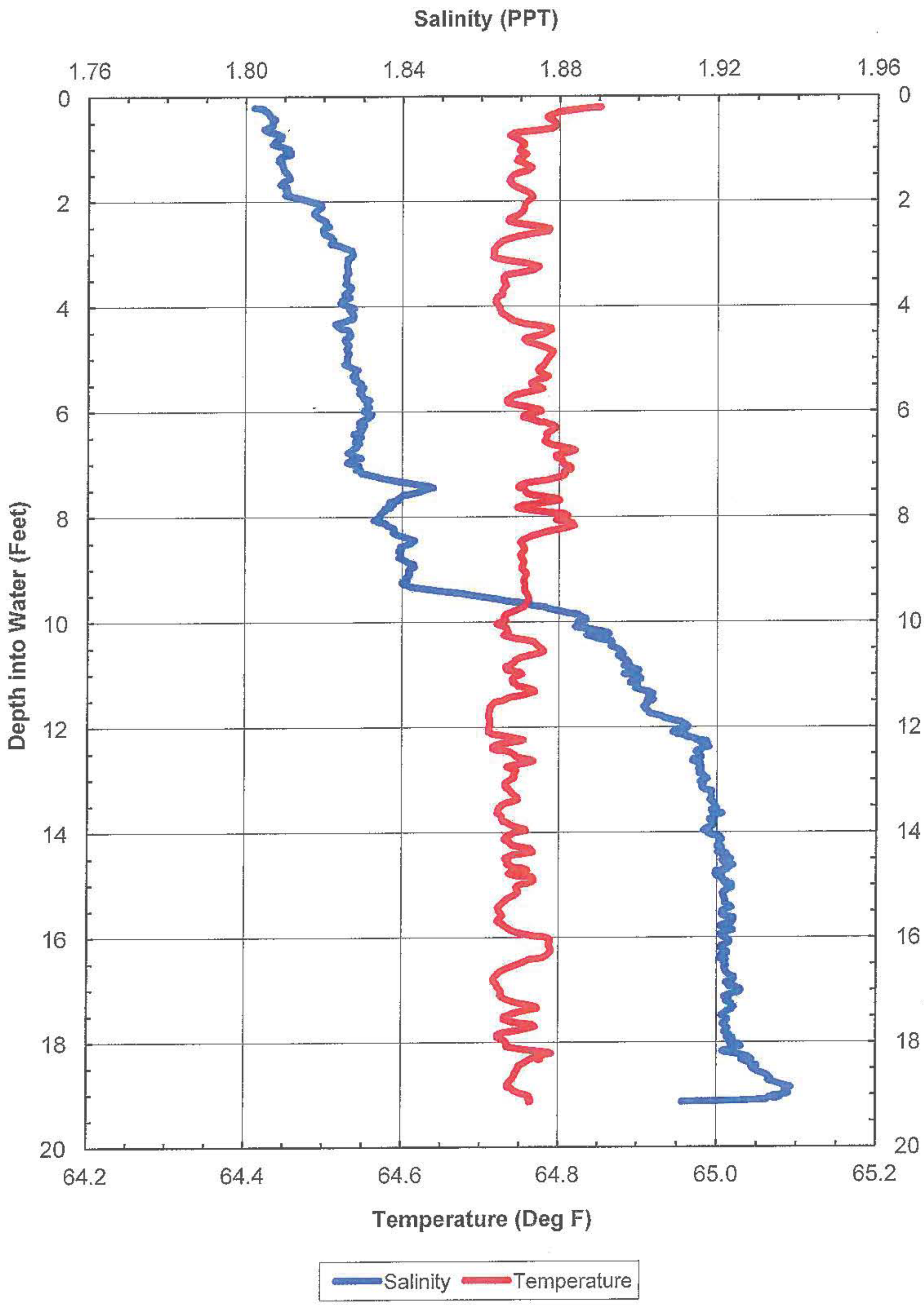
FIGURE 3-6
Location of Wells Within or Near Kaloko Makai Project Site
Kaloko Makai



Source: Tom Nance Water Resource Engineering, December 2012

FIGURE 3-7
Salinity and Temperature Profile Through the Water Column of Well 4160-02 (September 14, 2012)
Kaloko Makai

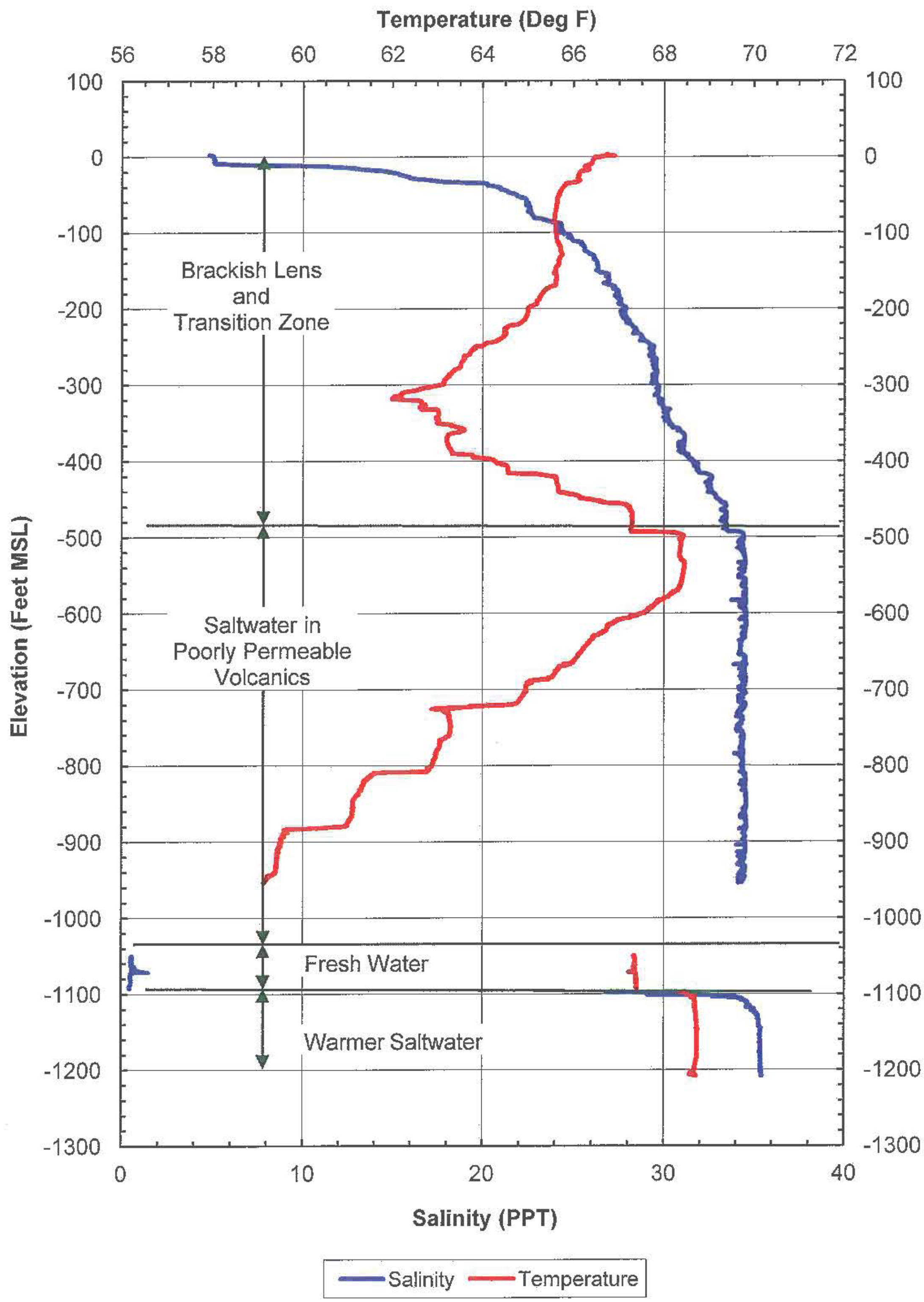
This is decidedly not the case for the basal lens between the Old Kona Airport and Keāhole Point. Indications are that the actual basal flowrate is less than one-third of what might be expected if all of the discharge from the high-level groundwater was into the inland margin of the basal lens.

High-level Groundwater Occurrence: High-level groundwater occurrence in North Kona was first discovered in 1990 with a well drilled in Keauhou at 1,620-foot elevation above Mamālahoa Highway. Since then, more than 20 high-level wells have been developed from Kalaoa in the north to Kealakekua in the south. With a few exceptions, all of these wells have been located above Mamālahoa Highway.

Data collected from the State's Keōpū Monitor Well (No. 3858-01) and Kamakana Monitor Well (No. 3959-01) (see Figure 3-8) provide insight into the possible geologic feature creating high level groundwater occurrence tapped by wells above Mamālahoa Highway and the resulting anomalous flowrate, salinity, and temperature in basal lens.

Both wells were drilled through the basal lens, continued through the underlying saline groundwater, and then encountered fresh and confined groundwater at depth. Prior to drilling the Keōpū Well, encountering fresh water at depth was unexpected. During drilling of the Kamakana Monitor Well, salinity and temperature of the water in the borehole were closely monitored, enabling the different groundwater regimes penetrated by the borehole to be accurately documented. These are described below and illustrated in Figure 3-8.

- Initially, a thin, relatively saline (5 parts per thousand (ppt)) and cool (66° F.) basal lens was encountered. The water level was typically about 2.5 feet (mean sea level (msl)) according to the available surveyed elevation. However, the mid-point of the transition zone of this basal lens is between 35 and 40 feet into water, suggesting that the water level may actually be less than two feet.
- Below the brackish basal lens is a thick transition zone which extends to a depth of 490 feet below sea level. In this transition zone, the water temperature steadily declines to 62° F at 320 feet below sea level and then the temperature trend reverses, increasing to 67° F at 490 feet below sea level.
- Below this thick transition zone, extending from 490 to more than 1,020 feet below sea level, the salinity is essentially that of seawater and the temperature steadily declines with depth to about 59° F.
- At 1,060 feet below sea level, fresh water was encountered. It was about eight degrees warmer than the saline groundwater immediately above it and had a piezometric head subsequently determined to be about 32 feet above sea level. The fresh water rushed up the borehole, mixing with the saltwater above for the first 150 feet, moving up the borehole for the next 720 feet with little or no mixing, and then mixing into the transition zone above that (Figure 3-9).
- The freshwater zone turned out to be less than 40 feet thick. At 1,100 feet below sea level, warmer (70° F.) and slightly hypersaline (35.4 ppt) groundwater was encountered. Drilling continued for another 120 feet with no salinity or temperature change.



Source: Tom Nance Water Resource Engineering, December 2012

FIGURE 3-8
Composite Profile Through the Water Column of the Kamakana Borehole (Profiles of 4/12/10, 6/5/10, and 8/18/10)
Kaloko Makai

In addition, the monitoring also showed that the freshwater zone had a substantial response to ocean tidal variations. Comparative tidal lags and amplitudes for the respective periods of recording are shown in Table 3-1.

Table 3-1
Tidal Lags and Amplitudes

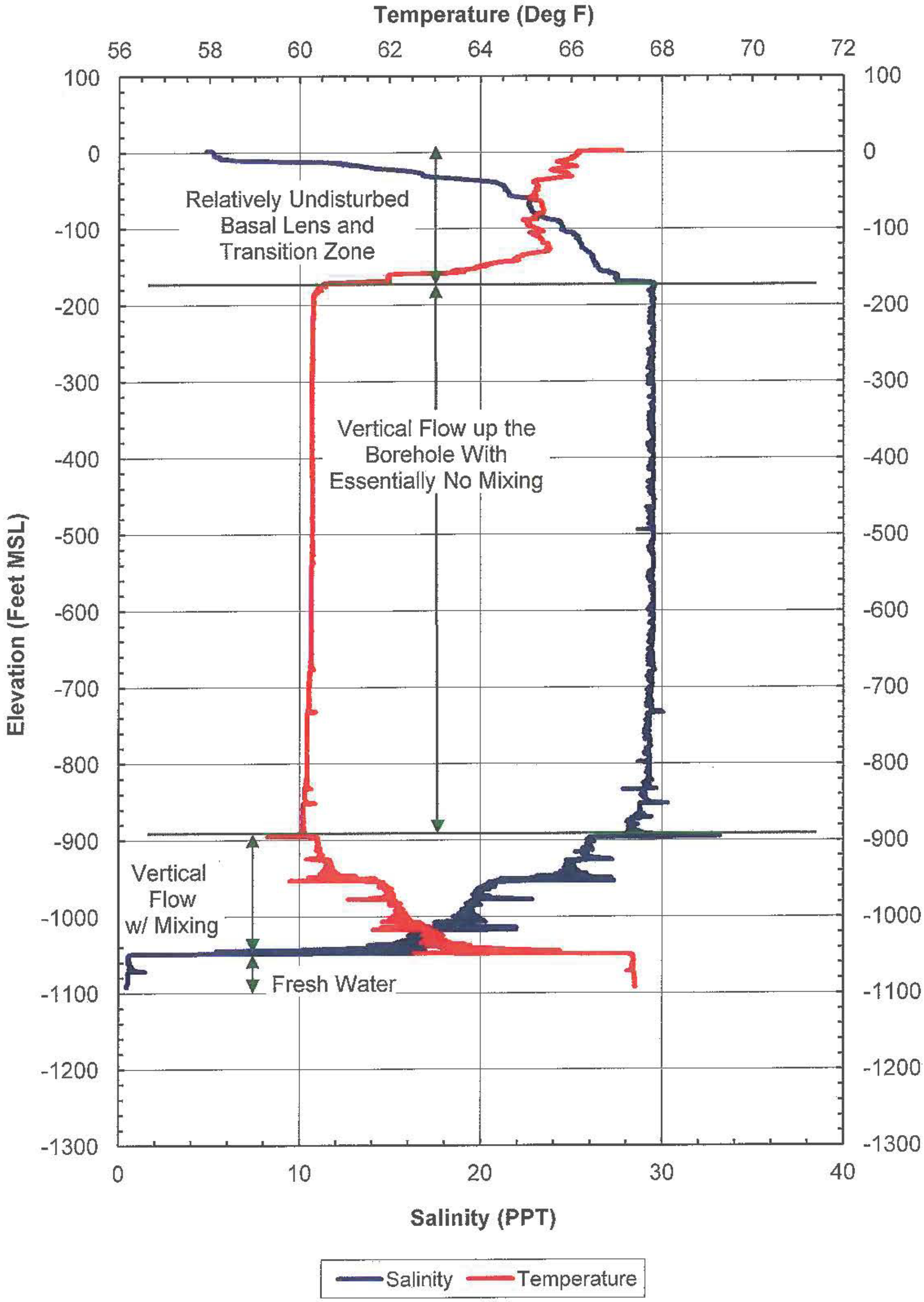
Groundwater Zone	Tidal Lag (Hours)	Tidal Amplitude (% of Ocean Tide)
Fresh Water Zone	1.0	48
Brackish Basal Lens	3.0	25
Source: TNWRE, July 2013 (Appendix C)		

Results of the two deep monitor wells provide insight on the relationship between high level and basal groundwater. Conclusions summarized below:

- The feature confining the fresh water at depth is a thick sequence of poorly permeable lava flows, in the aggregate hundreds of feet thick.
- That poorly permeable lava flows are the mechanism creating high level groundwater in Kona is also supported by the results of two high level wells located above Mamālahoa Highway (Hualālai State No. 4258-03 and Keōpū State No. 3957-05). During the construction and testing of these wells, water levels rose and yields increased by drilling deeper.
- The confined fresh groundwater at depth, with an apparent hydraulic connection to seawater at depth offshore, suggest that at least some of the inland high level groundwater may discharge at depth offshore rather than flow into the basal lens at is inland margin.
- With limited amounts of warmer, high level groundwater flowing into the inland margin of the basal lens, the source of the colder temperatures in the basal lens is seawater at depth moving inland in a saltwater circulation pattern beneath the basal lens.

<u>Rainfall-Runoff Generation and Disposal:</u> According to the *2011 Rainfall Atlas of Hawai'i* (Giambelluca and Others, 2011), average annual rainfall across the project site varies from 15 - 25 inches per year. The land surface at the project site consists of unweathered and very permeable lavas with sparse deposits of ash soils and no defined drainageways. Essentially no rainfall runoff leaves the site in its present conditions, even during intense storm events. It is either lost to evaporation or percolates to the underlying groundwater.

<u>Ground Water Quality:</u> Samples from wells, anchialine ponds, and other locations within and near the Kaloko Makai project site were taken for water quality analysis. Samples taken from high-level groundwater wells had low salinity levels and nutrient concentrations were reflective of natural, rather than man-made input (see Appendix C, Table 2). Samples from basal wells had higher salinities and varying nutrient concentrations. Samples were also taken from the upper end of Honokōhau Harbor and the discharge of the R-2 quality wastewater effluent from Kealakehe Wastewater Treatment Plant (WWTP).



Source: Tom Nance Water Resource Engineering, December 2012

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FIGURE 3-9
Profile Through the Water Column of the Kamakana Borehole After Fresh Water was Encountered (May 12, 2010)
Kaloko Makai

Kealakehe WWTP discharges approximately 1.3 mgd of effluent into a pit approximately 3,700 feet inland from Honokōhau Harbor on the mauka side of Queen Kaʻahumanu Highway. Nutrient removal from the WWTP effluent as it moves to and discharges into the upper end of Honokōhau Harbor is summarized below.

The inland excavation of the harbor acts as a point sink for groundwater discharge including the addition of the WWTP effluent into the groundwater. Travel from the pit disposal to the upper end of the Honokōhau Harbor consists of a 60-foot drop through the vadose zone and 3,700 feet of travel with groundwater to the upper end of the Harbor. The samples taken on November 9, and 21, 2011 at the upper end of the Harbor are a mix of: 1) the WWTP treated effluent that has underground natural nutrient removal, 2) the ambient groundwater, and 3) seawater.

Nutrient removal is calculated using several steps and the details are provided in TNWRE's report (see Appendix C). Based on these calculations, rates of removal of nitrogen are 89 to 92 percent; for phosphorous, the removal rates are 93 to 98 percent.

POTENTIAL IMPACTS AND MITIGATION MEASURES

The two primary project improvements potentially impacting groundwater resources are the alternatives for developing drinking water sources and the system for reclaiming wastewater generated by the Kaloko Makai development. These project improvements and their potential impacts are discussed below.

The following assumptions has been incorporated in estimating the project's impact on basal water.

Projected Drinking and Non-Drinking Water Demand: Drinking water use for Kaloko Makai will be limited to consumption, general household and commercial use, and irrigation of landscaping within individual single family residential lots. The average drinking water demand for Kaloko Makai at full build-out is estimated to be approximately 2.18 mgd. Table 3-2 summarizes the estimated water demand for Kaloko Makai.

Kaloko Makai will utilize non-drinking recycled water (R-1) from its on-site wastewater treatment plant for general irrigation of common landscaping features, including district-scale park, neighborhood parks, open spaces (as necessary), and the schools. At full build out, the projected irrigation use of R-1 recycled water is 0.57 mgd.

Water Source Alternatives: The drinking water system's well pumping capacity must provide the maximum day use (defined as 1.5 times the average use) in a 24-hour pumping day. If the wells are dedicated to and incorporated into the County Department of Water Supply (DWS) system, one-third of the well capacity would be allocated to DWS and two-thirds would be allocated to the developer. Three alternative drinking water sources are being considered (see Appendix C):

1. On-site Wells at 710-foot Elevation Within the Project Site (PREFERRED ALTERNATIVE)
2. On-site Wells at 710-foot Elevation with Reverse Osmosis (RO) Treatment
3. On-Site Wells at 363-foot Elevation with Desalinization of Saline Groundwater

Table 3-2
Drinking Water and Non-Drinking Water Demand
Average Daily Use

	Units	Landscape Units	Scale	gpd/Scale	Drinking Water (gpd)	Non-Drinking Water (gpd)
Phase 1						
SF Residential	471		units	SF <400/0>	188,400	-
MF Residential	1,281	387	units	MF <276/124>	353,556	47,988
Commercial	430,000		SF	430 Commercial ft2 <83/37>	35,690	15,910
Light Industrial	25	5	acres	<2000/2000> / acre	50,000	10,000
School	18	9	acres	<2400/1600> / acre	43,200	14,400
Parks	35	26.25	acres	<600/3400> / acre	21,000	89,250
Hospital	40	10	acres	200 units <400/0> <0/1600> / acre	80,000	16,000
Lodge	200		units	200 units <400/0>	80,000	-
WWTP	20	2	acres	Arbitrary	2,000	-
Electrical Substation	1	0.1	acre	Arbitrary	2,000	-
				Total Phase 1	**855,846**	**193,548**
Phase 2						
SF Residential	932		units	SF <400/0>	372,800	-
MF Residential	1,156	354	units	MF <276/124>	319,056	43,896
Commercial	145,000		SF	145 Commercial ft2 <83/37>	12,035	5,365
Light Industrial	25	5	acres	<2000/2000> / acre	50,000	10,000
School	12	6	acres	<2400/1600> / acre	28,800	9,600
Parks	10	7.5	acres	<600/3400> / acre	6,000	25,500
				Total Phase 2	**788,691**	**94,361**
Phase 3						
SF Residential	1,054		units	SF <400/0>	421,600	-
MF Residential	244	26	units	MF <276/124>	67,344	3,224
Commercial	40,000		SF	40 Commercial ft2 <83/37>	3,320	1,480
Light Industrial	25	5	acres	<2000/2000> / acre	50,000	10,000
School	12	6	acres	<2400/1600> / acre	28,800	-
Parks	11.2	8.4	acres	<600/3400> / acre	6,720	-
Fire Station	5.5	0.55	acres	<1800/1200> / acre	9,900	-

Table 3-2 (continued) Drinking and Non-Drinking Water Demand Average Daily Use						
	Units	**Landscape Units**	**Scale**	**gpd/Scale**	**Drinking (gpd)**	**Non-Drinking Water (gpd)**
Phase 3						
Desalination Plant	1.7	0.17	acres	Arbitrary	2,000	-
				Total Phase 3	**589,684**	**14,704**
Project Total (Average Demand)					**2,234,221**	**302,613**
Max Day Demand (gpd) (Average Demand x 1.5)					3,351,332	453,920
Peak Hour Demand (gpd) (Average Demand x 5)					11,171,105	1,513,065

Source: Wilson Okamoto Corporation, July 2013 (see Attachment P)
Note: the "Phase" estimates are based on "Average" daily use; there is a factor applied under "Project Total" to compute "Maximum" demand.
Assumptions based on Hawai'i County, Water System Standards, Domestic Consumption Guidelines (Hawai'i County WUDP):
Residential - 400 gpd per unit (all unit types: SF, MF low-rise or MF high-rise)
Commercial - 130 gpd per 1,000 sq. ft.
Light Industrial - 4,000 gpd per acre (or 17,000 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 or 60 gpd per student
Parks - 4,000 gpd per acre
(TOD Greenbelts and Dryland Forest not irrigated)
(Parks, Plazas, Squares, Roadways, etc irrigated with R-1 treated wastewater)
(Park 4 will use drinking water)

Alternative 1 – On-site Wells at 710-foot elevation Within the Project Site: The possibility of developing drinking water quality wells at 710-foot elevation is suggested by the discoveries of two deep monitor wells (State Nos. 3858-01 and 3959-01), both of which encountered fresh groundwater under artesian pressure at depth below saline groundwater and far below and hydrologically disconnected from the basal lens. A deep exploratory borehole at 710-foot elevation within the project site will be undertaken to determine if fresh groundwater can be found at depth at this site and to determine the feasibility of its development.

If successful, three production wells would be developed, each of 1,150 gallons per minute (gpm) capacity and driven by 350 horsepower motors. These wells would be integrated into the DWS system, with two-thirds of their capacity allocated to supply the Kaloko Makai project.

The project would consist of the following elements:

- Exploratory, then three production wells each with a 1,150-gpm, including line shaft pumps and appurtenances
- Pump control building
- Fencing
- Access road improvements
- Three, 1- to 2-mg concrete reservoir sizes (as required by DWS)
- Utilization of a 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 DWS and an agreement negotiated with the County DWS for use of the water.

<u>Alternative 2 – On-site Wells a 710-foot Elevation with Reverse Osmosis (RO) Treatment:</u> In the event that artesian groundwater is found below saline groundwater but its salinity at projected draft rates would not meet drinking water standards, the alternative of RO treatment of this water would be considered. This treatment process would produce a wastewater stream, referred to as a concentrate, that would be disposed of injection wells at the project's WWTP. Due to the required RO treatment, DWS may not accept the wells and RO treatment plant for dedication. In that case, the capacity of the wells, as feedwater sources for RO treatment, would be sized to provide the project's maximum day use in a 24-hour pumping day assuming 65 percent product recovery in the RO process.

As a private system, provision of standby well pumping capacity would be required. These criteria translate to four 1,150 gpm well pumps, with one as a standby. At full build-out, the disposal of concentrate would be 1.15 mgd as a year round average.

The project would consist of the following elements:

- Exploratory, then four production wells each with a 1,150-gpm, including pumps and appurtenances
- Pump control building
- Fencing
- RO treatment plant
- Access road improvements
- Three, 1- to 2-mg concrete reservoir (as required by DWS).

Cost of construction would be borne by Kaloko Makai. The system would be privately owned and operated.

<u>Alternative 3 - Desalinization of On-site Saline Groundwater</u>**:** In the event that the first two alternatives described above are not feasible, desalinization of on-site saline groundwater would be undertaken. The raw water supply wells and desalinization plant would be located next to or below DWS's existing 363-foot tank along Hina Lani Drive. The raw water supply wells would draw saline groundwater from beneath the basal lens. Tentatively, the depth from which this supply would be withdrawn would be between 250 and 350 feet below sea level, requiring total well depths on the order of 710 feet. The expectable production of drinking water from this saline feedwater supply is 40 to 45 percent, meaning that 2.5

gallons of saline groundwater would be required for every gallon of fresh product water produced. As a private system with redundant capacity, this would translate to four 750 gpm treatment trains with each treatment train supplied by 1,900 gpm raw water supply well.

To reduce the RO power requirements, pressure transfer devices would be installed to recover energy from the RO concentrate stream. The concentrate itself would be hypersaline (salinity on the order of 50 ppt compared to seawater at 35 ppt). Its disposal, amounting to 4.9 mgd at full build-out, would be in three deep wells located at the project's on-site WWTP.

The desalination plant would be situated near the existing 363-foot water tank and feed lines from the wells to the treatment facility and would follow along Hina Lani Street. The on-site desalination facility will include storage, transmission and distribution system proposed for Kaloko Makai. The desalination plant would treat the water through a RO process. Prior to RO, the feedwater from the wells is pre-filtered to remove particulates that can negatively affect the RO membranes. This pre-treatment 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 which removes dissolved solids. The water is then conditioned for pH adjustment and disinfection. The water can then be used as drinking water.

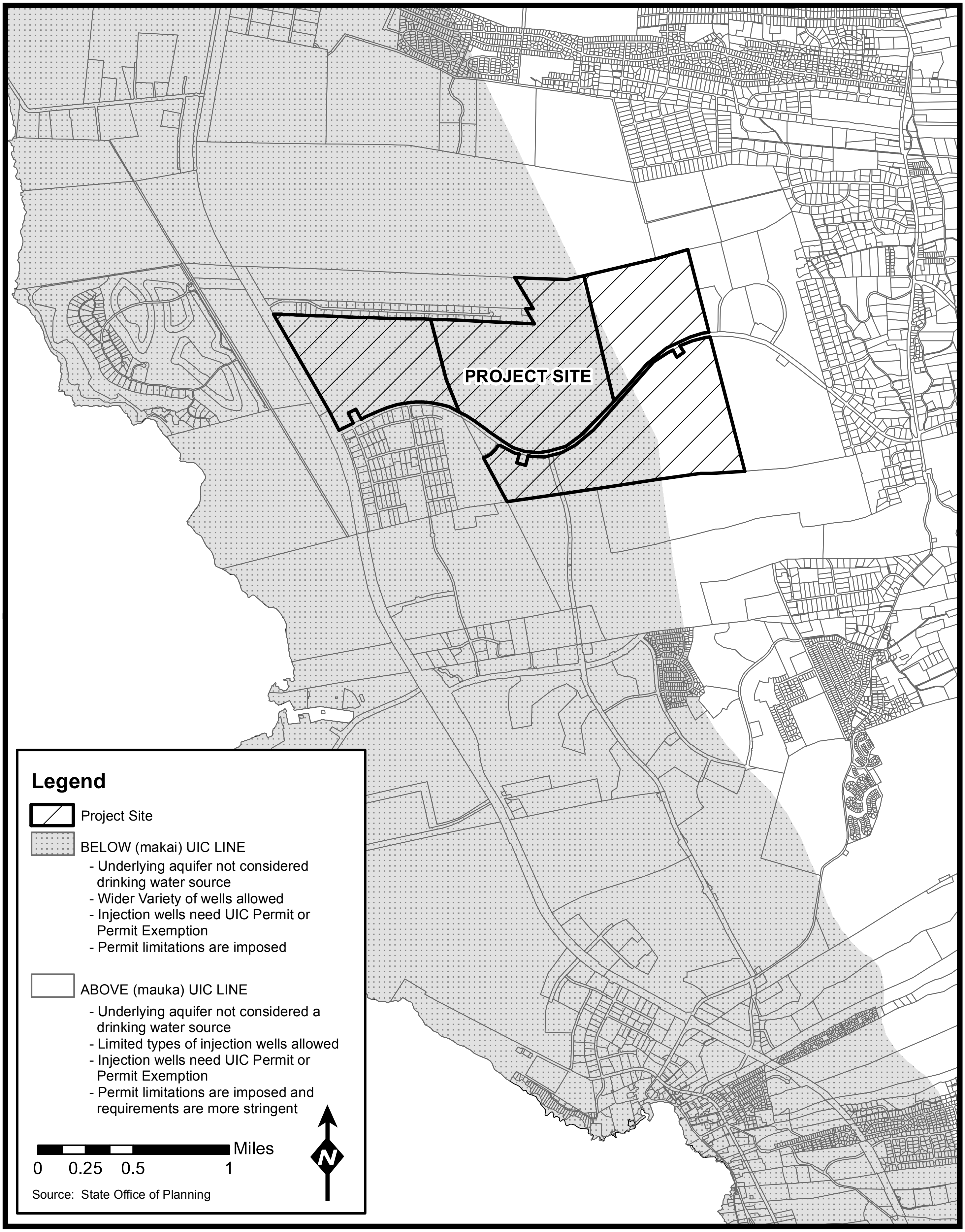
The wastewater of the RO process is a concentrated brine; it will be discharged in on-site deep disposal wells, at depths to avoid recirculation to the supply wells.

Since the concentrate would have 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 lens. It will then be 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. Figure 3-10 is the map of the region noting the UIC line.

In addition to drinking water and brine concentrate, 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.

Cost of construction would be borne by Kaloko Makai. The system would be privately owned and operated.



WILSON OKAMOTO CORPORATION

FIGURE 3-10
Underground Injection Control Area, Island of Hawai'i
Kaloko Makai

The proposed desalination system will be subject to regulation as a public water system and will meet conditions of the State DOH, including HAR Chapter 11-20, 11-21, and 11-25. The desalination water system will have no impact on drinking water 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.

In summary, two of the three drinking water source alternatives would drill wells at the mauka end of the project site. If successful, wells for these two alternatives would tap fresh or slightly brackish artesian groundwater which exists at depth below the basal lens and saline groundwater. One or the other of these options would only be pursued if it can be demonstrated, initially by testing in the exploratory borehole and subsequently by testing in the finished production wells, that pumping this water will have no impact on the basal lens above. Rather it would simply be tapping groundwater that flows beneath the basal lens and does not leak into it.

The third alternative, desalination of saline groundwater would utilize on-site wells designed to draw water from a substantial distance below the basal lens where the salinity would be 30 ppt or greater. Extensive testing would be undertaken in the development of these wells to affirmatively demonstrate that such pumping can be done without adversely impacting the overlying basal lens.

None of the alternative drinking water sources would utilize water from the brackish basal lens beneath the project site. Of the two alternatives that would draw from high-level groundwater, none would impact basal groundwater in the project's mauka-makai corridor or elsewhere in North Kona. However, these alternatives would result in a 1:1 reduction of fresh groundwater ultimately discharged into the marine environment offshore.

As an overarching philosophy in all source alternatives, Kaloko Makai is committed to water conservation strategies to reduce consumption, conserve resources and minimize water use. The goal is to reduce the total water use through a combination of water saving equipment and strategies.

A number of measures may be implemented to facilitate end-user conservation, including water restrictions during drier periods, public education and more efficient landscaping practices. Consumption could be significantly reduced through end-user conservation.

In providing sources of drinking water for Kaloko Makai, the Project 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.

Relationship of Basal to High Level Groundwater: It is assumed that no high-level groundwater leaks into the basal lens beneath the project site, in other words that flow in the basal lens is entirely due to local recharge on the area between Mamālahoa Highway and the shoreline. That flowrate is estimated to be 1.7 mgd per coastal mile. Across the 1.2 mile width of the project site, the basal flowrate is estimated to be 2.0 mgd. It should be noted that if some or most of the high-level groundwater is flowing into the basal lens, the project's relative impact on this greater basal flowrate would be less than calculated herein.

Ambient Quality of the Underlying Basal Groundwater: The salinity and nutrient levels in samples taken from on-site Well 4160-02 are assumed to represent the ambient quality of the underlying basal groundwater. These averages are: salinity of 1.75 ppt; total nitrogen of 80 micromolar (µM) or 1.12 milligrams/liter (mg/l); and total phosphorous of 5.5 µM or 0.17 mg/l.

R-1 Quality Wastewater for Landscape Irrigation: Landscape irrigation will be supplied by both the drinking water and non-drinking water systems, the former occurring primarily in single family residential areas which will not be supplied by the non-drinking water system. The use of drinking water for this purpose at full build out is estimated to be 0.46 mgd, calculated as an average of 4,000 gpd/acre on 115 acres throughout the project site (see Appendix C). Irrigation using R-1 effluent as the source of supply would be about 0.57 mgd. That means the excess of R-1 for disposal in injection wells at the project's WWTP site would be about 0.90 mgd.

For the calculations herein regarding the percolation of excess applied irrigation water to the underlying basal lens, three assumptions are made:

(1) 12 percent of the water applied for irrigation will be in excess of landscaping requirements and percolate to the basal groundwater below.
(2) TN and TP in the R-1 effluent are assumed to be 1,500 and 200 µM, respectively, based on levels of these nutrients in the effluent from the County's Kealakehe WWTP (Table 2 in Appendix C).
(3) Fertilizer levels where landscape irrigation is supplied by R-1 effluent will be far less than where the supply is the drinking water system.

Assumed fertilizer applications for landscaping are:
- In areas irrigated with drinking water, nitrogen and phosphorus in fertilizers will be applied at 3.0 and 0.5 pounds/year/1,000 sq. ft., respectively.
- In areas irrigated where R-1 effluent, nitrogen and phosphorus in fertilizers would be applied at 10 percent of the rate applied with drinking water irrigation.
- Ten percent of the applied nitrogen and two percent of the applied phosphorus will be carried in the excess applied irrigation water below the plant root zone.

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 drinking water to the R-1 storage tank will be required to ensure the irrigation demands can be met.

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.

As a long-term average, it appears that the value of R-1 treated wastewater effluent will exceed its on-site irrigation reuse by about 0.90 mgd. If other uses cannot be found for this water, this excess will be disposed of in injection wells located at the project's WWTP. The wells would be designed to deliver this excess at depth below the basal lens so as not to impact the lens itself.

To accomplish this, disposal would be at and below where the receiving groundwater salinity is 30 ppt or greater. This may require the injection wells to deliver the water at depths of 300 feet or more below sea level.

On-Site Rainfall Recharge: It is assumed that 60 percent of the project site's 20 inches of average annual rainfall percolates to and becomes groundwater recharge. This amounts to an average of 1.0 mgd. Drainage features of the development will capture surface runoff and direct it to seepage basins and drywells, resulting, as a first order approximation, in no change in the amount of onsite rainfall ultimately becoming groundwater recharge. However, it is also assumed that nutrient levels in the post-development rainfall percolating to groundwater will be increased by 20 μm and 2 μm for nitrogen and phosphorous respectively.

Natural Removal of Nutrients Originating from Kaloko Makai: As previously mentioned rates of removal of nitrogen are 89 to 92 percent; for phosphorous, the removal rates are 93 to 98 percent.

Table 3-3 summarizes the aforementioned assumptions to estimate possible changes to the brackish basal lens beneath the project site as a result of the project. The resulting estimates are: a 6.2% increase in the flowrate; a 5.1 percent reduction in salinity; and nitrogen and phosphorous increases of 5.2% and 2.1%, respectively.

Table 3-3
Approximated Changes to the Basal Groundwater Flowing Beneath the Kaloko Makai Project Site

Item	Flowrate (mgd)	Salinity (ppt)	Nitrogen (lbs/day)	Phosphorous (lbs/day)
Present Groundwater Flow	2.0	1.75	18.66	2.83
Excess Applied Irrigation				
• As Drinking Water + Fertilizer	0.055	0.15	0.502	0.011
• As R-1 Treated Wastewater + Fertilizer	0.70	0.30	0.210	0.007
Change in Local Rainfall – Recharge	No change	No change	0.280	0.041
Post Development Totals				
• Amount	2.125	1.651	19.652	2.889
Percent Change	+6.2	-5.1	+5.2	+2.1

Source: An Assessment of the Potential Impact of the Proposed Kaloko Makai Project on Water Resources, TNWRE, July 2013.
Notes:
1. *The area irrigated with drinking water is 115 acres. The amount of water used for this purpose is 0.46 MGD.*
2. *The area irrigated with R-1 effluent is 165 acres. The amount of R-1 used for this purpose is 0.57 MGD*

Changes to Groundwater Discharge into Marine Environment

Three other aspects of the project's development, although not having an impact on the basal lens, will affect the ultimate discharge of groundwater into the marine environment. Each of these are summarized below.

Consumptive Use of Drinking Water Quality Groundwater: Two of the three drinking water source alternatives would draw from high-level groundwater at depth below the basal lens. The project's ultimate drinking water use would be 2.1 mgd as a year-round average. Wells developed for such use would actually draw 3.27 mgd, one-third of which would be used by DWS to serve other customers in its service area. If desalinization is necessary (Alternative 3), the draft would be slightly greater than 3.3 mgd.

Based on the Keauhou Aquifer recharge calculations in Engott 2011, this total draft for the Project and DWS would represent a two to three percent reduction of the total groundwater discharge into the marine environment offshore of the aquifer. It appears that some or most of this change would be occurring at substantial depth and distance offshore with no significant impact.

Disposal of Excess R-1 Effluent via On-site Injection Wells: The R-1 treated wastewater effluent generated by the project will exceed its on-site irrigation reuse by an estimated 0.90 mgd. If other uses cannot be found for this effluent, then the excess would be disposed in injection wells. The wells would be designed to deliver the excess effluent at depth below the basal lens so as not to impact the lens itself. Disposal of the R-1 effluent would be at and below where the receiving groundwater salinity is 30 ppt or greater and below poorly permeable lava flows identified in the process of drilling. This may require the injection wells to deliver the R-1 effluent at depths of 300 feet or more below sea level. However, the extraordinary disposal depth is warranted to avoid having a significant impact on basal groundwater moving through Kaloko- Honokōhau National Park or to the Park's nearshore waters. The effluent disposed of would be significantly less dense than the receiving basal groundwater. The tendency for the disposed R-1 effluent to rise up due to its lesser density would be offset by: disposal beneath one more poorly permeable lava flows; the substantial vertical to horizontal anisotropy in the lava flows, and progressive mixing of the effluent into the receiving groundwater, causing its density to increase.

Potential Disposal of RO Concentrate: Two of the three alternative drinking water sources being considered involve desalinization. In the event water for Alternative 1 does not meet DOH standards for drinking water use (i.e. too saline,) then Alternative 2 will be implemented and the groundwater will be desalinated in an on-site reverse osmosis (RO) desalination facility. This desalinization will produce a wastewater, referred to as concentrate, which at full build out would be approximately 1.15 mgd (60 to 70% product recovery). If the salinity of the feedwater supply is between 2.0 and 3.0 ppt, the salinity of the concentrate would be in the range of 5.3 to 8.2 ppt. The concentrate will be brackish, assumed to be too saline for irrigation reuse, and would therefore require disposal in one or two wells, different from the injection wells used for excess R-1 effluent disposal. The wells will be designed to deliver the RO concentrate to below the midpoint of the transition zone between brackish basal water above and saline groundwater below in order to avoid impacting the overlying basal lens. With such disposal, the RO concentrate would flow toward the shoreline, discharge beneath the basal groundwater below the National Park's anchialine ponds. It may emerge into the National Park's nearshore waters where it would quickly be mixed to background levels.

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.

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 DOH, designed to prevent violations of State water quality standards as a result of storm-water discharges originating from the Project. Such BMPs will be documented in a declaration of covenants, conditions and restrictions, that will be recorded against the property and will run with the land.

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 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. It is anticipated that the PPP will be similar to the "Declaration Regarding Pollution Prevention Plan for West Hawaiʻi Business Park." No grading activity will take place on the property until the PPP has been prepared.

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.

3.5.2. Nearshore Marine Environment and Ponds

Marine Research Consultants, Inc. (MRC) prepared *An Assessment of Marine and Pond Environments in the Vicinity of Kaloko Makai Project* (December 2012). The assessment is summarized below and the report in its entirety is included in Appendix D.

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 and ponds 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. Shoreline pools formed in the basalt bench include intertidal seaweeds, 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 Hawaiʻi. 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 and, as in most areas of West Hawaiʻi, the most diverse coral communities on the reef are found in the mid-reef zone. Moving down the reef slope, coral settlement and growth cease at a depth of approximately 25 meters (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 ʻAimakapā), tidal areas and wetlands. Over half of this 1,160 acre National Park is comprised of ocean waters.

3.5.2.1. Water Chemistry

Water samples were collected in February 2012 and November 2012 along transects that bisected Kaloko and ʻAimakapā Fishponds in an inshore-off-shore direction. Ten sampling stations were established approximately equidistantly along each transect extending from the most landward shoreline of the ponds to the seaward shorelines. For the February 2012 data collection, sampling continued into the ocean from the shoreline for a distance deemed to reach open coastal waters. No ocean sampling was conducted in November 2012. Sampling of the ponds and ocean during previous surveys in 2000 and 2007 were conducted in an identical manner. In addition, in February 2012 samples were collected from three anchialine pools within the Park.

3.5.2.1.1. Physical Characteristics of ʻAimakapā and Kaloko Ponds

Examination of the marine and pond water chemical analyses for samples collected in ʻAimakapā and Kaloko Ponds and the adjacent ocean during four survey increments from 2000 to 2012 show several major patterns of horizontal stratification of water chemistry constituents in the ponds and the ocean (refer to Tables 1 – 5 and Figures 4 – 17 in Appendix D for sampling results). The most obvious characteristic of the data set is the major differences between patterns of water quality constituents in ʻAimakapā /Kaloko Ponds and the ocean. The second most apparent difference in water chemistry is the variation in the patterns of distribution of water chemistry constituents between ʻAimakapā Pond and Kaloko Pond. These variations between the two large fishponds are primarily the result of differences in physical structure of the barriers between the ponds and the ocean. ʻAimakapā Pond is separated from the ocean by a fairly wide (~20 m) continuous sand berm which 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, Silica (Si), TN, TP, Total Organic Nitrogen (TON), Total Organic Phosphorous (TOP)) in ʻAimakapā Pond.

While both ponds contain thick sediment bottoms, there is a substantial difference in the quality of the sediment. Bottom composition of ʻAimakapā 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.

3.5.2.1.2. Horizontal and Vertical Stratification

During all sampling events, salinity within ponds showed very different horizontal gradations from the ocean to the shoreward sides of the ponds. In ʻAimakapā Pond, average salinity during the four surveys ranged from 12.45‰ in November 2012, 12.44‰ in February 2012, 12.67‰ in 2007 and 3.17‰ in 2000. The overall salinity in ʻAimakapā averaged over all four surveys was 12.64‰, with a standard deviation of 0.43‰. These data indicate that the salinity in ʻAimakapā is remarkable constant over the entire area of the entire pond, as well as over the 12-year interval of sampling. There is however, a slight trend of freshening over time, with the 2012 samples exhibiting the lowest salinities. The constancy of salinity through both time and space in ʻAimakapā Pond is clearly evident (refer to Figure 4 in Appendix D).

The overall pattern of salinity in Kaloko Pond was substantially different than in ʻAimakapā. Average salinity in the fishpond during the four increments of sampling was 22.93‰ in November 2012, 24.52‰ in February 2012, 19.59‰ in 2007 and 33.02‰ in 2000. The overall average salinity in Kaloko Pond for all surveys was 24.8‰ with a standard deviation of 6.1‰. As Kaloko Pond is "connected" to the ocean, the variability in salinity is a result of sampling at various stages of tide, and is also likely a response to the various stages of construction of the rock wall separating the pond from the ocean. All of the samplings of Kaloko Pond exhibited a pattern of increasing salinity with decreasing distance from the shoreline, indicating gradient of mixing between seawater and groundwater. The overall patterns of salinity, with the lowest values in 2007 and the highest in

2000 do not suggest any consistent pattern with respect to time as a function of groundwater input into the pond.

Examination of the marine and pond water chemical analyses for samples collected in ‘Aimakapā and Kaloko Ponds and the adjacent ocean during four survey increments from 2000 to 2012 reveal slight vertical gradients in salinity in all sample sets with a surface layer of fresher water overlying a water column of saltier water. In ‘Aimakapā Pond, salinity of surface samples was generally about 0.1-0.2‰ lower than bottom samples. In Kaloko Pond, the differences between surface and bottom samples was up to 2-4‰. The difference in vertical stratification between the ponds reflects the different levels of input and mixing between ocean water and groundwater, which are both lower in ‘Aimakapā relative to Kaloko.

Comparing values of salinity within ‘Aimakapā Pond to salinities of anchialine pools located in Kaloko-Honokōhau National Historical Park indicate that salinity in the fishpond is within the range of salinity as water in three representative pools water (8-14‰), while the salinity in Kaloko Pond is substantially higher than anchialine pools (Refer to Table 1 in Appendix D). These comparisons again point to the open circulation between Kaloko Pond and the ocean.

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. While this was the general pattern observed on the Kaloko-Honokōhau National Historical Park transect sites in 2007 and 2012, 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. These gradients indicate that mixing of groundwater entering the ocean does not completely homogenize the water column, with a surface layer of lower salinity water overlying a water column of ocean water.

As a result of the differences in permeability between the two ponds and the ocean, the patterns of dissolved nutrients vary considerably between ponds. Throughout Kaloko Pond there was little variation in nutrient concentrations. Concentrations of nitrate + nitrite nitrogen (NO_3^-), Si, orthophosphase (PO_4^{3-}) and ammonium (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 2000 / 2007 and 2012. With the exception of NO_3^- and NH_4^+, water in ‘Aimakapā Pond in 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 2000. In February 2012 and

November 2012 concentrations of NO_3^- at the inshore end of ʻAimakapā exhibited peak values with rapidly decreasing concentrations to the center of the pond. The magnitude of the gradients were also different between February and November 2012 surveys. The pattern of the other major inorganic nutrient, PO_4^{3-} exhibits a similar pattern, with high values at the shoreward end of the pond sharply decreasing values to the center of the pond.

These differences in gradients suggest the possibility of a qualitatively different level of groundwater input at the mauka end of ʻAimakapā Pond in 2012 relative to past surveys. While it is unlikely that the magnitude of groundwater flux has increased, it is possible that influx varies as a result of water level in the ponds. It has been shown that ʻAimakapā Pond responds to tidal fluctuations (damped relative to the ocean cycle in both magnitude and time) which push pond water inland during flood tides and draw groundwater into the ponds during ebbing tidal cycles.

During both 2012 surveys, the metabolic functioning of ʻAimakapā appears to have shifted toward a more "open" system. High input of low salinity water containing high concentrations of inorganic nutrients found in groundwater is evident along the inland shoreline of the pond. These concentrations decrease with distance seaward until the approximate center of the pond, where concentrations approach the levels found in 2000. TON and pH mirror the pattern of nutrients indicating gradients of progressive uptake and metabolic processes from the mauka edge toward the center of the pond. Hence, the recent data indicates steep gradients within ʻAimakapā Pond indicate that the entire system does not remain a completely heterotrophic system removing nutrients from the water column, while adding back end products of metabolic decomposition. Rather, the apparent increase in groundwater now results in indications that at least part of the pond is a more open system with respect to metabolic cycling reversing somewhat the progression toward an anoxic system. It may be however, that the differences between nutrient gradients in different sampling years is a response to sampling during different phases of the tidal cycle, with nutrient fluxes into the pond more pronounced during ebbing tides.

3.5.2.1.3. 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 been adopted by the State DOH as a new protocol for evaluating compliance with water quality standards in West Hawaiʻi.

All of the concentrations of NO_3^- in ʻAimakapā and Kaloko Ponds lie far below the mixing line, suggesting that there is substantial uptake of NO_3^- within the ponds. While the actual concentrations of NO_3^- are slightly lower in Kaloko Pond compared to ʻAimakapā 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 ʻAimakapā Pond than in Kaloko Pond.

The same processes of NO_3^- uptake occurring in the two large fishponds is not occurring in the anchialine pools. Rather, groundwater nutrients remain in essentially the same concentration while in the anchialine pool as in the submarine aquifer. Such a difference in nutrient cycling in the smaller anchialine pools relative to the fishponds is a result of far more rapid flushing and turnover rate of water in the pools.

Phosphate phosphorus (PO_4^{3-}) is a major component of fertilizer and sewage effluent, but is usually not found to leach to groundwater to the extent of NO_3^-, owing to a high absorptive affinity of phosphorus in soils. Higher concentration at the shoreward end of ʻAimakapā Pond indicates a source of PO_4^{3-} that is not completely naturally occurring groundwater. However, the near-vertical linear array of data points indicates rapid uptake of PO_4^{3-} beyond the shoreward edge of the pond. PO_4^{3-} concentrations in Kaloko Pond also reflects mixing of groundwater and ocean water along with uptake by biotic activity within the pond, although the magnitude of uptake is less than in ʻAimakapā Pond. Data for anchialine ponds indicates that there are no external sources of PO_4^{3-} to the anchialine pools from sources other than naturally occurring groundwater.

Concentrations of NH_4^+ above mixing line are not a result of mixing of groundwater and ocean water. Rather, these concentrations are the result of either input from another source, or as is more likely the case, from *in-situ* metabolic processes within the ponds.

TON and TOP occur in very low concentrations in both open ocean water and high-level groundwater. The occurrence of TOP and TON far above the mixing lines likely reflects the metabolic cycling conversion of inorganic nutrients to organic nutrients by plant metabolism and decomposition in ʻAimakapā Pond. Owing to low circulation and flushing of the majority of ʻAimakapā Pond, and no uptake by biotic function, these organic nutrients remain in the water column. Contrary to ʻAimakapā Pond, the data points of TOP and TON versus salinity fall near the mixing lines, indicating that the level of organic decomposition and/or flushing of the pond is not occurring at the same level in Kaloko Pond. Within the anchialine pools, TON and TOP occur at very low levels, supporting the observation that rapid water exchange in the pools prevents accumulation of the products of organic metabolism.

Two major points can be made to summarize the results of the mixing analyses. First, and most importantly, there are no indications of significant input to any of the ponds of inorganic nutrients from sources other than naturally occurring groundwater. None of the data points scaling inorganic nutrients to salinity within the ponds or nearshore ocean indicate substantial nutrient subsidies to groundwater that could be a result of human activities in upland areas. The constituents that show substantial elevations in the ponds (NH_4^+, TON and TOP) are not the direct result of nutrient loading, but rather byproducts of metabolic cycling coupled with long residence time (slow water exchange) within the ponds.

The second major point that is illustrated by the nutrient data and mixing plots is that during the recent samplings in 2012 ʻAimakapā Pond exhibited a far more detectable pattern of active groundwater flux than in previous surveys. At the inland shoreline of the pond, input of low salinity, high nutrient groundwater was clearly evident during both of the 2012 surveys. Such input was not present in earlier surveys utilizing identical sampling methods. While the nutrient inputs were rapidly taken up within the shoreward half of the pond, the input of groundwater suggests a more active circulation than in the past. While the process responsible for these differences in input over a decadal period are not readily decipherable, it is clear that there is no indication of increased senescence of ʻAimakapā Pond. Rather, the measured increase in circulation indicates that the pond may be stabilizing the trend of tending toward a system completely dominated by decomposition and infilling of sediment.

While not included in the present data presentation, past investigations of the Kaloko-Honokōhau National Historical Park area have included comparisons of the nutrient dynamics occurring in the fishponds to the effects of discharges of water from the Natural Energy Laboratory of Hawaiʻi (NELHA) at Keahole Point. These comparisons indicate that subsidies to groundwater of NO_3^- and PO_4^{-3} are far greater at NELHA than in the Kaloko-Honokōhau area as a result of high concentrations in deep seawater that is discharged into disposal trenches along the shoreline.

3.5.2.1.4. Pond Metabolism

The major concern regarding impacts to the pond resources at the Kaloko-Honokōhau National Historical Park 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 ʻAimakapā Pond over a one-week period in December 2001 – January 2002.

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.

3.5.2.2. Pond Sediment

Samples were collected at the seaward ends of ʻAimakapā Pond, Kaloko Pond, and one of the anchialine ponds in order to evaluate the presence of toxic compounds. In summary, none of the 28 organochlorides, 20 organophosphates, or 10 chlorinated herbicides were detected in any pond sediment.

Of the 40 semivolatile organics, the only compound above the level of detection was phenol, which was present in a sample collected from Kaloko Pond at a concentration of 0.14 mg/kg. Phenol was detected in previous surveys. Phenols are ubiquitous in the environment as they are a naturally occurring component of all foods, particularly plants, and are considered an antioxidant. They are also used in cosmetics, mouthwashes, disinfectants and in the synthesis of manufactured surfaces.

Metal analysis detected aluminum, arsenic, barium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selemium, vanadium and zinc from all three sampling stations (ʻAimakapā Pond, Kaloko Pond, and one anchialine pond).

3.5.2.3. Biological Community

As previously described, Kaloko Pond is separated from the ocean by a rampart of basaltic boulders, while ʻAimakapā Pond is separated from the ocean by a solid berm of beach sand. The main structural feature of the offshore area seaward of both ponds is a shallow basaltic ledge of pāhoehoe lava. The ledge is particularly wide fronting ʻAimakapā Pond. Adjacent to the Kaloko Pond frontage the shoreline is composed of a rocky shoreline composed primarily of outcrops of lava that extend seaward.

Because of the structure of the boulder rampart and beach berm that separate the ponds from the ocean, there is virtually no intertidal area. Beyond the boulder shoreline, the structure of the offshore environment off of Kaloko generally conforms to the pattern that has been documented as characterizing much of the west coast of the Island of Hawaii (Dollar 1975, 1982, Dollar and Tribble 1993).

The zonation scheme consists of three predominant regions:

1. Beginning at the shoreline and moving seaward, the shallowest zone beyond the shoreline is comprised of a seaward extension of the basaltic shoreline bench, consisting largely of essentially bare basalt surfaces. The most abundant coral occupying the nearshore bench is *Pocillopora meandrina*, a sturdy hemispherical coral is the dominant colonizer of the nearshore area. This species is able to flourish in areas that are physically too harsh for most other species, particularly due to wave stress. The shallow flat pavement area directly in front of the Kaloko Pond seawall appears to be an ideal habitat for *Pocillopora meandrina*. Other corals in the area consist of hemispherical heads of *Porites lobata*, and flat encrustations of *Montipora* spp.

2. Moving seaward, the flat nearshore bench area terminates in a ledge that has a roughly vertical face that extends to a depth of approximately 25 feet. Beyond the ledge, bottom topography consists of a reef platform that is typical of West Hawaiʻi. The transition area between the shallow flat pavement zone and the reef platform zone is characterized by high relief in the form of undercut ledges and basaltic boulder pinnacles. This area provides an ideal locale for colonization by attached benthos, particularly reef corals, and generally the widest assortment of species and growth forms are encountered in this region. The predominant coral in the area in *Porites lobata*, which occurs in a variety of growth forms.

3. The seaward edge of the reef platform (at a depth of about 50 feet) 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. The predominant coral cover in the slope zone is typically interconnected mats of "finger coral" (*Porites compressa*), which grow laterally over unconsolidated substrata.

The physical structure of the offshore region at ‘Aimakapā is somewhat different than off Kaloko. The nearshore area consists of an extended flat basalt shelf that extends approximately 100 m from shore. The surface of the platform contains holes and fissures, and small sand-filled channels, but relatively low cover of living corals. At the seaward termination of the shelf, a reef crest consisting of a shallower ridge of limestone separates the inner bench from the outer reef, which is similar to that described above off of Kaloko Pond.

The predominant taxon of macrobenthos (bottom-dwellers) throughout the reef zones off of Kaloko Pond are Scleractinian (reef- building) corals. In total, eight species of "stony" corals, and two "soft corals" were observed throughout the region of study. Overall coral cover consisted of 40% of bottom cover, with bare basalt rock comprising 33% of bottom cover. The dominant species in all of the zones off Kaloko and ‘Aimakapā Ponds was *Porites lobata* which comprised 66% of coral cover. The next most abundant species were *Porites lutea (11%), Porites compressa* (10%), and *Pocillopora meandrina (9%)*. These four species comprised 96% of all coral cover. Other species that occurred across the reef were *Montipora capitata, M. patula* and *Pavona varians*.

The mid-depth reef platform zone had the highest number of coral species at both survey sites. In the mid-depth zone, dominant species were *Porites lobata* and *Porites compressa*. *Porites lobata* occurs in various growth forms including flat encrustations and large dome-shaped colonies, which are responsible for much of the true "reef" accumulation in the mid-depth zones. Coral cover on the outer reef platform comprised approximately 40-60% of bottom cover.

The other dominant group of macroinvertebrates are the sea urchins (Class Echinoidea). The most common urchin was *Echinometra matheai*, which occurred in all reef zones. *E. matheai* are small urchins that are generally found within interstitial spaces bored into basaltic and limestone substrata. *Tripneustes gratilla*, and *Heterocentrotus mammillatus* were other species of urchins that occurred commonly throughout the reef.

Sea cucumbers (Holothurians) observed during the survey consisted of three species, *Holothuria atra*, *H. nobilis*, and *Actinopyga obesa*. Numerous sponges were also observed on the reef surface, often under ledges and in interstitial spaces.

Frondose benthic algal occurrence was extremely limited throughout the study area off of Kaloko. However, encrusting red calcareous algae (*Porolithon spp.*, *Peysonellia rubra*, *Hydrolithon spp.*) were common on the boulders and exposed rocks throughout the study area. These algae were also abundant on bared limestone surfaces, and on the nonliving parts of coral colonies.

Reef fish community structure was largely determined by the topography and composition of the benthos. The reef fish community off Kaloko and ‘Aimakapā Ponds is typical of that found along most of the Kona Coast, as described by Hobson (1974), and Walsh (1984). Fish community structure can be divided into six general categories: juveniles, planktivorous damselfishes, herbivores, rubble-dwelling fish, swarming tetrodonts, and surge-zone fish.

Pomocentridae (Damselfish) were the most abundant family of fish. Planktivorous damselfish, principally of the genera *Chromis* and *Abudefduf* were abundant in all areas surveyed. The next most abundant family was the Acanthuridae (surgeonfish), with the most common species including the yellow tang (*Zebrasoma flavescens*), the goldring surgeonfish (*Ctenochaetus strigosus*), and the brown surgeonfish (*Acanthurus nigrofuscus*). On the shallower reef terrace, adult whitebar surgeonfish (*Acanthurus leucopareius*), orangeband surgeonfish (*A. olivaceus*), and parrotfish (*Chlorurus sp.*) were also common in areas where coral rubble was abundant.

Surge zone fish consisted principally of herbivores such as rudderfish (*Kyphosus bigibbus*), surgeonfish (*Acanthurus spp.*), and unicornfish (mostly *Naso lituratus*). Saddle wrasse (*Thallassoma duperry*) and surge wrasse (*T. purpureum*) were also abundant in the surge zone. Trigger fish (Family Balistidae) and a variety of butterfly fish (Family Chaetodontidae) were also observed throughout the survey region.

Overall, fish community structure at Kaloko appeared fairly typical of the assemblages found in West Hawaiʻi reef environments.

ʻAimakapā pond is separated from the ocean by a fairly wide 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. 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.

Anchialine pools are 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.

One of the most obvious differences is between water quality in ʻAimakapā 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.

While both ponds contain thick sediment bottoms, there is a substantial difference in the quality of the sediment. Bottom composition of ʻAimakapā 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.

3.5.2.4. 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 is known to feed on selected species of macroalgae. The endangered hawksbill turtle *(Eretmochelys imbricata)* is known infrequently from waters off the Kona Coast. The area off of ʻAimakapā Pond is clearly a preferred habitat for green turtles, as at least eight individuals were observed in the nearshore zone during the survey. In addition, at least ten turtles were observed hauled out on the basalt shelf to the south of the pond during a low tidal stand when much of the basaltic bench in this area was exposed.

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 seal that is endemic to the waters off of the Hawaiian Islands. No whales or monk seals were observed during the survey.

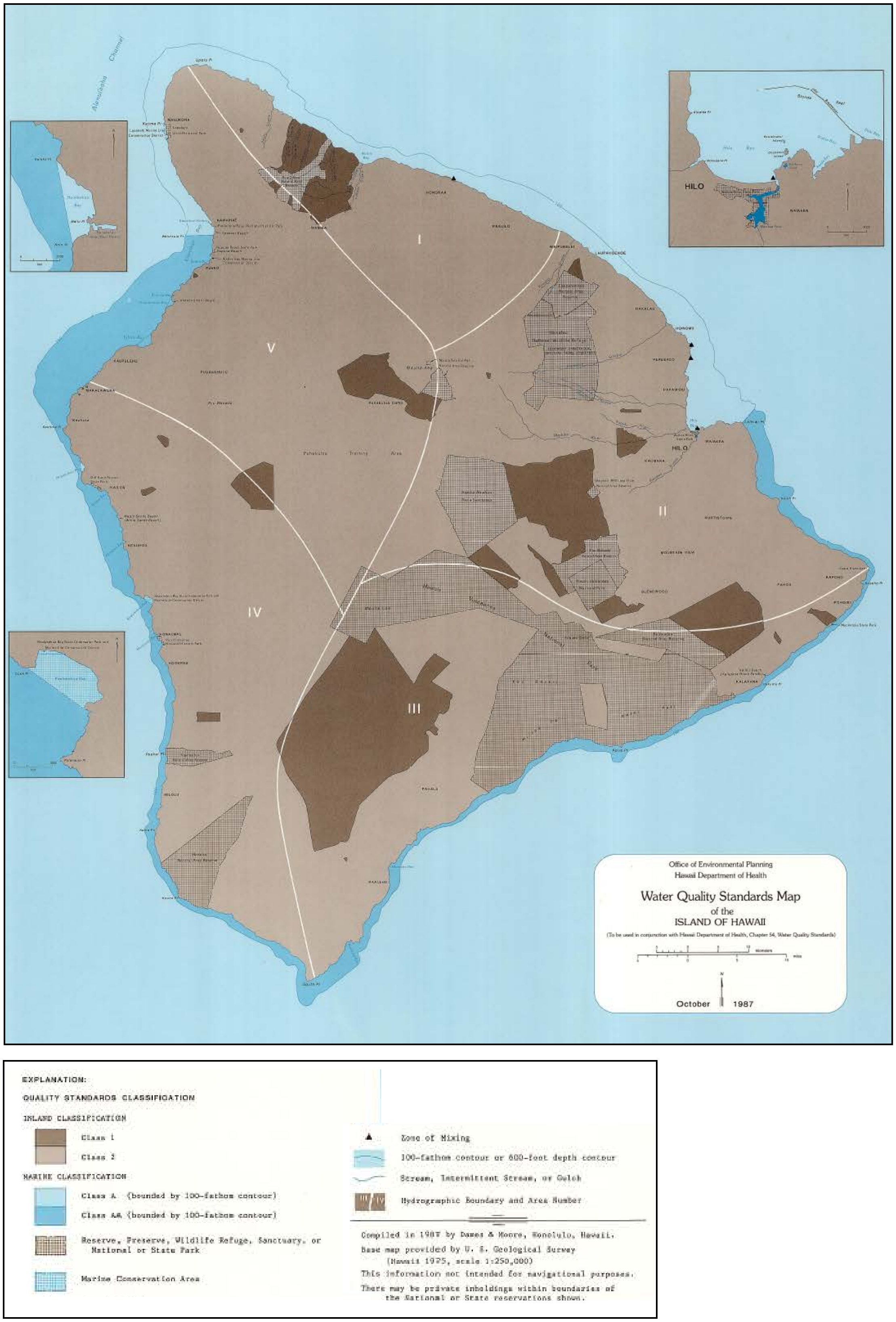
3.5.2.5. Water Quality Standards

Pursuant to Hawaiʻi Administrative Rules (HAR) Title 11, Chapter 54, Water Quality Standards, the State 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.

As a point of reference, State DOH objective of Class "A" waters is that their use for recreational purposes and aesthetic enjoyment should be protected. 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 (HAR-11-54-3(c)(1)(B)). However, the classification of any water area as Class “AA” shall not preclude other uses of waters compatible with the objectives set forth in HAR 11-54-3.

Along the Kona coast, and essentially around most of the island of Hawaiʻi (from Kawaihae heading south around South Point up to Leleiwi Point near Keaukaha,) State DOH has classified the nearshore waters as “AA” (see Figure 3-11). The coastal area below the Kaloko Makai project is classified both class “A” and “AA” (see Figure 3-12).



Source: State of Hawaii, Department of Health

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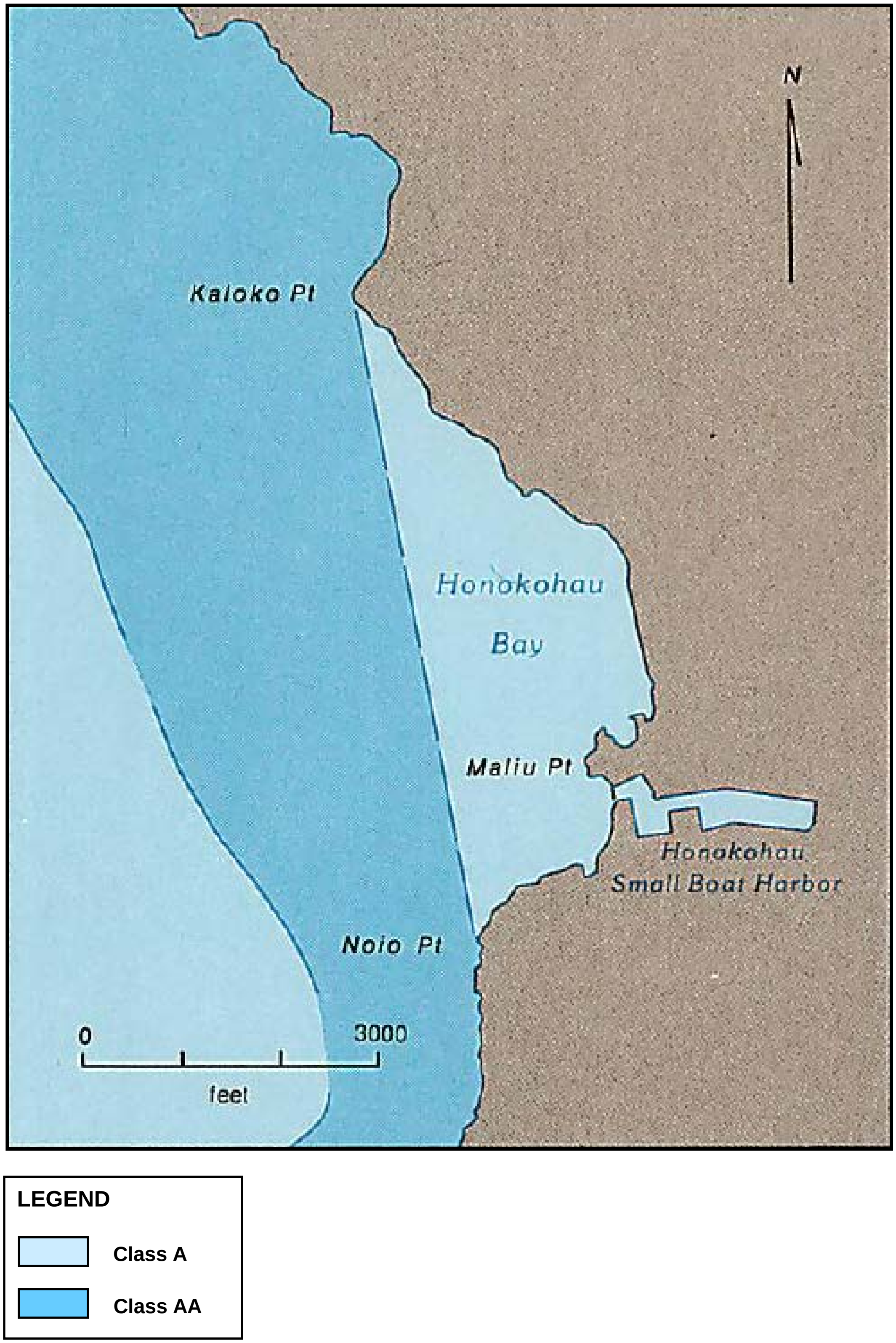
FIGURE 3-11
Water Quality Standards Map, Island of Hawai‘i
Kaloko Makai



Source: State of Hawaii, Department of Health

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FIGURE 3-12
Honokōhau Bay, Class A Waters
Kaloko Makai

POTENTIAL IMPACTS AND MITIGATION MEASURES

Ponds

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 Hawaiʻi. 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; the result of balance between short residence time of water within the ponds, and production and consumption by pond biota. The excess nutrients do not lead to algal dominated water columns (at least until late stages of pond senescence), however, as a result of a balance between short residence time of water within the ponds, and production and consumption by pond biota. 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.

ʻAimakapā 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).

During surveys of ʻAimakapā Pond conducted in 2000 and 2007 restricted groundwater flow into ʻAimakapā Pond was borne out by the near complete lack of both vertical and horizontal gradients within the ponds. Such lack of detectable inputs suggested that the pond is essentially a closed system which is accumulating sediment and metabolic decay products which cannot be naturally flushed from the enclosed pond basin. 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.

During a survey in early 2012 conducted for the present report, evidence of groundwater input at stations within the inshore half of ʻAimakapā Pond was detected as steep horizontal gradients of salinity and inorganic nutrients found in groundwater. To determine whether this situation was an anomaly, another sampling was conducted in November 2012. Results of this sampling indicated an even stronger flux of groundwater into ʻAimakapā Pond than was previously measured. These results suggest that ʻAimakapā Pond may be experiencing either increased groundwater input, or at least not a decrease in groundwater input relative to a decade earlier. As the existing development in the Kaloko Industrial area upslope of the Kaloko-Honokōhau National Historical Park ponds has been in place for the last decade, water quality in the ponds changes can be assumed to be influenced by the present level of development upslope from the Kaloko-Honokōhau National Historical Park ponds.

Hence, while all data indicate that while the enclosed basin of ʻAimakapā is characterized by long water residence time, resulting in continued deposition of organic sediment, the recent detection of increased groundwater flux suggests that the pond is still functioning in part as an anchialine system, and has no yet reached a final stage of senescence.

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 ʻAimakapā 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.

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. 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.

In addition, the predominant direction of wind is inland, and not toward the ocean and thus there is little potential for significant input of sediment to the marine and pond environment.

The entire floors of Kaloko and ʻAimakapā Ponds are covered with a thick layer of fine-grained flocculent sediment. 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.

Groundwater Flow and Composition

Five aspects of the project development have the potential to change the groundwater flowrate and/or chemistry:

1. Consumptive use of drinking water quality groundwater.
2. Disposal of excess R-1 treated effluent in on-site injection wells.
3. Potential disposal of RO (reverse osmosis).
4. Percolation of excess landscape irrigation.
5. Change in local rainfall-recharge.

Detailed consideration of these five factors is discussed in Section 3.5.1 and also discussed in detail in Appendix C (TNWRE, 2012).

Post-development total changes to basal groundwater flowing beneath the Kaloko Makai Project site are summarized as follows:

Percentage change in groundwater flowrate (mgd) = + 2.125
Percentage change in salinity (‰) = -5.1
Percentage change in nitrogen (lbs per day) = +5.2
Percentage change in phosphorus (lbs per day) = +2.1

Based on the results of the water chemistry analyses discussed in earlier in this section, these changes in groundwater parameters can be considered in terms of impacts to the ponds at Kaloko-Honokōhau National Historical Park. In terms of groundwater flow, it is estimated that the project will result in increased groundwater flux through the aquifer, as well as a decrease in salinity of basal groundwater, primarily as a result of increases in irrigation rates. As the linkage between the physical and metabolic dynamics of the ponds depends on flux of fresh groundwater, the potential increase in flow rate and decrease in salinity cannot be viewed as a negative impact to the ponds. Rather, increased groundwater flux can be viewed as a positive effect as it will enhance water exchange and decrease residence time within the ponds. Potential lowering of salinity of water entering the ponds will not result in effects to pond biota in terms of exceeding an upper salinity tolerance. As noted previously, recent surveys indicate an apparent progressive increase in groundwater flux in ʻAimakapā Pond which is reflected in nutrient concentrations, and a net reduction in metabolic decay products. With projected increased flux from the proposed development, conditions in the ponds could potentially improve further in a direction away from sediment deposition and senescence.

Wastewater generated at the project site and treated in an on-site treatment plant would be reused for irrigation, with the excess disposed of in injection wells if other uses are not found. Using typical nutrient concentrations in wastewater, fertilizers and basal groundwater, as well as changes in local rainfall and recharge and removal rates associated with lateral travel with groundwater to the shoreline (TNWRE 2012) estimated that total nitrogen and total phosphorus would increase by 5.2% and 2.1%, respectively over existing conditions (see Table 3-1).

Such increases in nutrient loading of less than 6% for N and 2% for P will not result in changes to the ponds or nearshore ocean. As described above, healthy anchialine ponds are not nutrient limited, and already contain an excess of nutrients that are not utilized within the biogeochemical cycles within the ponds. So the small projected increases would be inconsequential to anchialine pools.

If all of the metabolically relevant nitrogen and phosphorus in groundwater is considered as NO_3^- and PO_4^{3-}, then the projected increases would result in basal groundwater concentrations would be 75 µM for NO_3^-, and 5.0 µM for PO_4^{3-}. Such changes are well within the natural variability of the system, and essentially represent no change to present conditions. As an example, the average concentration of NO_3^- in high groundwater at present (80 µM) exceeds the projected increase value for NO_3^- in basal groundwater that would reach the shoreline (75 µM). Other areas of West Hawaiʻi also have been shown to have concentrations of NO_3^- in basal groundwater that exceed 75 µM (Dollar and Atkinson 1992). Thus, the projected increase cannot be considered of a magnitude to present any king of potentially problematic situation. As long as there are no changes to the physical structure of healthy anchialine ponds (e.g., infilling) or changes to the balance of native biotic assemblages (e.g., introduction of alien species) the small increase in nutrient concentrations in groundwater entering the ponds would have no effect.

Nearshore Environment

It is 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. 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 far less than have occurred at Keauhou.

With respect to impacts to coral reef ecosystems, seasonal long-period swells result in turbulence at the shoreline off the entirety of Kaloko-Honokōhau National Historical Park, including the nearshore areas off of ʻAimakapā and Kaloko Ponds. Such wave turbulence is the reason coral communities are poorly developed in the nearshore area. Hence, owing to the high and consistent rates of mixing, as well as minimal input of materials from land to the ocean, it is not likely that nutrient concentrations in the waters downslope from the project site will have any effect on marine communities.

In addition, some clarification on the actual extent of potential damage to coral reefs from nutrients is also important to note. While the perception is that elevated nutrient concentrations are universally detrimental to corals and other reef organisms, the scientific literature does not bear this out as fact (see Appendix D). Studies have shown that 57 species of corals have grown in seawater with consistent nutrient concentrations about 10-fold higher than is normally found on Hawaiian reefs and corals can be seen covering sewage diffuser that are actively discharging primary treated effluent within Hilo Bay.

Endangered, Threatened and Protected Marine Species

Development of Kaloko Makai will not involve any work in the nearshore region. Kaloko Makai will not alter access to the shoreline. Development does not involve any 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. Thus, there is little potential for any negative factors associated with the project that may affect turtles or marine mammals. The development of the project will not result in the take of any endangered, threatened and protected marine species.

Mitigation Measures

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.

Construction 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 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 Hawaiʻi 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 occupancy, Kaloko Makai will implement and maintain storm and surface-water runoff BMPs, subject to any applicable review and approval of the State DOH. Those BMPs will be designed to prevent violations of State DOH water quality standards as a result of storm-water discharges originating from the Project.

As previously mentioned, Kaloko Makai will develop a Pollution Prevention Plan (PPP) that provides 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. There will be an emphasis on BMPs that prevent or limit pollutants arising out of the permitted uses within the Project from reaching the groundwater and ocean.

Kaloko Makai will construct and operate an on-site 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: 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). The WWTP will be subject to conditions of approval by the State DOH, including any lower concentrations of TN and/or TP in the effluent, and HAR Chapter 11-62.

Effluent disposal for the Private WWTP shall be in accordance with all applicable laws. Monitoring of the 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.

An on-site WWTP will be self-sufficient, water efficient and environmentally sound. The Kaloko Makai facility will treat the wastewater to provide R-1 quality water for general irrigation within Kaloko Makai and thus lessen demand for drinking 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 Highway 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 will develop a groundwater monitoring plan, to detect contaminants in the groundwater below the Project. The groundwater monitoring plan will include monitoring wells and a sampling and analysis plan. Parameters to be analyzed will include pH, temperature, salinity, nitrate, ammonia, dissolved organic nitrogen (DON), total dissolved solids (TDS), TN, phosphate, dissolved organic phosphorus (DOP) and TP and any other parameters required by the DOH. The sampling frequency shall begin prior to the start grading activity, and shall be conducted quarterly for two years, or as required by the State DOH.

3.6. FLORA

At least seven botanical surveys in or adjacent to the project site 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 U.S. Fish and Wildlife Service (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 (see Appendix E). In March and May 2010 the USFWS surveyed 264.5-acres around and including the Kaloko Dryland Forest. In 2011, David and Guinther surveyed a portion of the Kaloko Makai property for the new Kona Courthouse site selection process. Most recently in May of 2012, David and Guinther conducted a biological survey as an update to the survey conducted by Isle Botanical in 2006 (see Appendices F and G).

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. The CH2M Hill botanical survey stated that three of the species recorded were federally listed endangered species. Five individuals of the sedge Kuk (*Cyperus fauriei* known at that time as *Mariscus fauriei*) were noted growing on a single boulder at about 115-m. elevation on the ʻaʻā flow. Two trees of ʻaiea (*Nothocestrum breviflorum)* were noted growing on the ʻaʻā flow at 110-m. elevation. Two mature individuals of maʻoloa (*Neraudia ovata)* were noted growing on the ʻaʻā lava flow at 115-m. elevation.

The checklist for the Char and Associates botanical survey on the property adjacent to the present project site listed a total of 47-species present, but none of these were federally listed.

In 2003, a USFWS survey team (USFWS 2003a & b) noted finding one live specimen of maʻoloa (*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 koʻokoʻolau (*Bidens micrantha* spp. *Ctenophylla)* in low numbers and one dying hala pepe (*Pleomele hawaiiensis)* 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 (which did not include a few cultivated species planted along the roadsides). The report in its entirety is included herein as Appendix E. Twenty-five of the species encountered are native and eleven of these native species are endemic. The majority of the 93 species encountered during the survey are naturalized "alien" plants that were accidentally or intentionally introduced to Hawaiʻi, but which have now become established in the islands and can spread on their own. Only one species found during the survey, hala pepe *(Pleomele hawaiiensis*,) is a federally listed endangered species. The other three endangered plant species, Kuk (*Cyperus fauriei*,) ʻaiea (*Nothocestrum breviflorum*,) and maʻoloa *(Neraudia ovata*,) previously reported from the Kaloko Dryland Forest were not encountered during this 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, ʻaiea (*Nothocestrum breviflorum*), maʻoloa (*Neraudia ovata*), hala pepe (*Pleomele hawaiiensis*), and uhiuhi (*Caesalpinia kavaiensis)*. Additionally, koʻokoʻolau (*Bidens micrantha* spp. *ctenophylla)* which is a candidate species for listing, was also present.. The USFWS survey recorded one ʻaiea (*Nothocestrum breviflorum*), one maʻoloa (*Neraudia ovata*), approximately twenty-five hala pepe (*Pleomele hawaiiensis*), one uhiuhi (*Caesalpinia kavaiensis)* and over 400 koʻokoʻolau (*Bidens micrantha* spp. *ctenophylla).* Kuk *(Cyperus fauriei)*, previously reported within the Kaloko Dryland Forest was not encountered during the surveys.

In 2011, David and Guinther surveyed ten sites of roughly comparable size for the new Kona Courthouse site selection process. Total species recorded combining all ten sites in the North Kona area was 68. Of these, 17 (25%) were native, with 6 (9%) endemic.

David and Guinther conducted a follow-up study for the Kaloko Makai project in May 2012. The report is included in its entirety as Appendix G. The Biological survey's purpose was to determine if there had been any significant changes in the habitats and/or botanical resources on the property since a similar survey was conducted on the site in 2006. David and Guinther (2012) compared species lists from previous studies with their current research.

The survey team utilized wandering transects that traversed all vegetation types in the project area.

A plant checklist was compiled from field observations. Table 3-4 is a list of "native" plants observed during the survey. A complete list of plants observed is included in Appendix G.

A total of 112 different plant species were recorded as growing on the surveyed parcels. Of these, 33 species (29.5 percent) are recognized as truly native (indigenous or endemic species). A little more than half of these (~18 or 54 percent) are moderately common indigenous plants (defined as native to both Hawaiʻi and elsewhere in the Pacific Basin) and the remaining 15 (45 percent) are endemic species (plant species uniquely native to the Hawaiian Islands). Three early Polynesian introductions (kukui or *Aleurites moluccana*, noni or *Morinda cirtifoloia*, and bitter yam or *Discorea bulbifera*) have been recorded in recent surveys. These results are rather atypical for lowland surveys in the Hawaiian Islands in the high percentage of native species recorded.

Most botanical surveys in the lowlands of any of the main Hawaiian Islands typically yield less than 12 percent native species including early Polynesian introductions (and less than 1 percent if biomass of native and non-native plants is compared) (David and Guinther, 2011).

Table 3-4 Native (and early Polynesian introduced) Plants						
Family and Species	Common Name	Status	Abundance (by vegetation type)			Notes
			PS	LF	PF	
FERNS AND FERN ALLIES						
NEPHROLEPIDACEAE						
Nephrolepus exaltata hawaiiensis Wagner	sword fern	**End**	--	--	U2	
PTERIDACEAE						
Doryopteris decipiens (Hook.) J. Sm.	*kumuniu*	**End**	+ R	--	--	<2, 3>
Doryopteris decora Brack	---	**End**	--	R	--	
PSILOTACEAE						
Psilotum nudum (L.) P. Beauv.	*moa*	**Ind**	--	R	--	<2>
FLOWERING PLANTS DICOTYLEDONS						
ARALIACEAE						
Polyscias sandwicensis (A. Gray) Lowry & G. M. Plunkett	*'ohe makai*	**End**	--	+ O	--	<1, 2, 3>
ASTERACEAE						
Bidens micrantha ctenophylla (Sherff) Nagata & Ganders	---	**End**	--	O	--	<2>
Melanthera populifolia (Sherff) Wagner & Rob	*nehe*	**End**	--	R	--	<2>
CAPPARACEAE						
Capparis sandwichiana DC	*maiapilo*	**End**	+	+ O	R	<1, 2, 3>
CONVOLVULACEA						
Ipomoea indica (J. Burm.) Merr.	*koali'awa*	**Ind**	+	O	--	<1, 2, 3>
EBENACEAE						
Diospyros sandwicensis (A. DC.) Fosb.	*lama*	**End**	--	+	O	<2, 3>
EPHORBIACEAE						
Aleurites moluccana (L.) Willd.	*kukui*	Pol	--	--	U1	<2>
Euphorbia celastroides Boiss.	*'akoko*	**End**	--	R	--	<2>
FABACEAE						
Caesalpinia kavaiensis H. Mann	*uhiuhi*	**End**	--	R	--	
Erythrina sandwicensis Degener	*wiliwili*	**End**	--	--	--	planted in
Senna gaudichaudii (Hook. & Arn.) H. Irwin & Barneby	*kolomona*	**Ind**	--	O	--	"D"
Sophora chrysophylla (Salisb.) Seem.	*mamane*	**End**	--	O	--	<2>
Tephrosia purpurea (L.) Pers.	*'auhuhu*	**Ind**	+	--	--	<2>
						<3>
GOODENIACEAE						
Scaevola sericea Vahl.	*naupaka*	**Ind**	--	R	--	<2>
LAMIACEAE						
Plectranthus parviflorus Willd.	*'ala'alawainui wahine*	**Ind**	--	R	--	<2>
MALVACEAE						
Abutilon incanum (Link) Sweet	*hoary abutilon*	**Ind**	+ R	--	--	<1, 3>
Sida fallax Walp	*'ilima*	**Ind**	+ U	U	R	<1, 2, 3>
MENISPERMACEAE						
Cocculus orbiculatus (L.) DC	*huehue*	**Ind**	+ O3	+ A	U	<1, 2, 3>
MYOPORACEAE						
Myoporum sandwicense A. Gray	*niao*	**Ind**	--	+ C	--	<1, 2, 3>
MYRTACEAE						
Metrosideros polymorpha Gaud.	*'ōhi'a*	**End**	--	+ U	--	<1, 2, 3>
FLOWERING PLANTS DICOTYLEDONS						
NYCTAGINACEAE						
Boerhavia repens L.	*alena*	**Ind**	--	+	--	<3>
PAPAVERACEAE						
Argemone glauca (Nutt. ex Prain) Pope	*pua kala*	**End**	R	R	--	<2, 5>
PIPERACEAE						
Peperomia leptostachya Hook. & Arn.	*'ala'alawainui*	**Ind**	+ R	R	R1	<2, 3>

Table 3-4 Native (and early Polynesian introduced) Plants (continued)

Family and Species	Common Name	Status	Abundance (by vegetation type)			Notes
			PS	LF	PF	
FLOWERING PLANTS (continued) *DICOTYLEDONS*						
ROSACEAE						
Osteomeles anthyllidifolia (Sm.) Lindl.	*ʻulei*	**Ind**	--	R	--	<2>
RUBIACEAE						
Morinda citrifolia Hillbr.	*noni*	Pol	U	R	U	<1, 2, 3>
Psydrax odoratum (Forst. f.) A.C. Smith & S. Darwin	*alaheʻe*	**Ind**	+ O	+ R	A	<1, 2, 3>
SAPINDACEAE						
Dodonaea viscosa Jacq.	*ʻaʻaliʻi*	**Ind**	+ U	U	C	<2, 3>
SOLANACEAE						
Nothocestrum breviflorum A. Gray	*ʻaiea*	**End**	--	R	--	
Solanum americanum Mill.	*pōpolo*	Ind?	+ R	--	--	<1, 3>
STERCULIACEAE						
Waltheria indica L.	*ʻuhaloa*	Ind?	+ U3	+ O	--	<1, 2, 3, 4>
MONOCOTYLEDONS						
AGAVACEAE						
Pleomele hawaiiensis Deg. & Deg.	*halapepe*	**End**	--	U	--	<2>
DIOSCOREACEAE						
Dioscorea bulbifera L.	bitter yam	Pol	--	--	--	<2>
POACEAE						
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	*pili*	**Ind**	+	--	--	<2, 3>

Source: David and Guinther, May 17, 2012 (see Appendix G)

Legend

Status = distributional status
- End: Endemic; native to Hawaiʻi and found naturally nowhere else.
- Ind: Indigenous; native to Hawaiʻl, but not unique to the Hawaiian Islands.
- Nat: naturalized; exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.

Abundance = occurrence ratings for plants on property in March 2008
- R: Rare, only one or two plants seen.
- U: Uncommon, several to a dozen plants observed.
- O: Occasional, found regularly, but not abundant anywhere.
- C: Common, considered an important part of the vegetation and observed numerous times.
- A: Abundant, found in large numbers; may be locally dominant.
- AA: Abundant, very abundant and dominant; defining vegetation type.

Numbers (as in R3) offset occurrence ratings (1 – several plants; 2 – many plants, 3 – abundant in a limited area) in cases where distribution across the survey area may be limited, but individuals seen are more than indicated by the occurrence rating along.

Notes:
- <1> Reported at Site "A" (Kaloko Makai) in David and Guinther (2011).
- <2> Recorded by Whistler (2006).
- <3> Recorded by Char (1995) on an adjacent property.
- <4> Ruderal, on highway verge and other highly disturbed areas.
- <5> Plant lacking flowers or fruit at time of survey; identification uncertain.

The survey by Char (1995) was for only the 224-acre portion of the site below 300-feet elevation (TMK: [3] 7-3-09:017) and therefore extensive comparisons with either Whistler (2006) or the present survey would not be particularly instructive. Whistler, on the other hand, surveyed all five project parcels, so a comparison with the present survey undertaken some five years later can be made.

Whistler developed a list of 93 plant species found on the project property (see Appendix F). He observed 17 species of naturalized plants not seen in 2012 (David and Guinther) and two species of native or early Polynesian plants (pili or *Heteropogon contortus* and hoi *or bitter yam*) not seen in 2012 (David and Guinther). Thus, 74 species were observed in common between the 2006 and 2012 surveys. A majority (~12) of the naturalized species recorded by Whistler and not seen in 2012 (David and Guinther) are herbs and could easily be missed if conditions were drier in 2012 (David and Guinther) than in 2006 (Whistler). Many of the naturalized herbs are mentioned as characterizing his managed land vegetation type (that is, disturbed land). Pili grass is mentioned in association with the lowland *Leucaena* scrub and was likely overlooked in this area in 2011. Three of the species are trees (African tulip or *Spathodea campanulata*, *Macaranga tanarius*, and ʻopiuma or *Pithecellobium dulce*), but no indication is given as to where these were observed. The first two would require conditions on the wet side and thus could only occur in the uppermost, forested (PF) area.

Curiously the larger roving sailor (*Lophospermum erubescens*) described as a “common” escaped ornamental vine on the LF1 lava flow by Whistler in 2006, was not observed at all in 2012. *Lophospermum* is described in Wagner, Herbst, and Sohmer (1999) as sparingly naturalized in “dry forest, alien grassland, and shrubland on Oʻahu and Hawaiʻi.” Possibly, the implication that this alien species was common (Whistler, 2006, p. 6) is at the root of the discrepancy. This species was recorded by Nishida (1993) from the LF1 area. We expect that there would be year-to-year differences in the presence of many herbaceous species, often dependent upon rainfall amounts.

Of significance in terms of native species not seen by either Whistler (2006) or the present survey are the listed plants: maʻoloa (*Neraudia ovata)* and Kuk (*Cyperus fauriei)*. Also significant are the rare natives, uhiuhi (*Caesalpinia kavaiensis*) and ʻaiea (*Nothocestrum breviflorum*), variously recorded from the area in the past, but not observed by Whistler. David and Guinther recorded single individuals of each in 2012—and, as evidenced by flagging and fencing, are clearly well-known to be present. Rare natives and their general distribution on the project site are discussed further in this section.

Hawaii Forest Industry Association (HFIA) contracted Kukui Planning Company (with guidance from USFWS) to do a rare plant survey of the Kaloko Makai Dryland Forest Preserve. The survey was completed in January 2012 (Kukui Planning Company, LLC). Koʻokoʻolau, uhiuhi, maʻaloa and halapepe were observed within the Dryland Forest. In addition to the above species a variety of common species were observed including ʻohe makai, huehue, māmane, ʻalaʻala wai nui wahine, maiapilo, naio, koali awa, ʻuhaloa, ʻūlei, ʻiliahi, ʻakoko, kolomona, ʻilima, kuluʻī, and nehe.

Vegetation Types

Whistler (2006) recognized four types of vegetation on the property: (1) managed land vegetation; (2) *Leucaena* or koa haole scrub; (3) Christmas berry scrub; and (4) dryland forest.

David and Guinther (2012) distinguished six substratum/vegetation types, which are further described below:

LF1 - ʻaʻā flow less than 3000 years old
LF2 - ʻaʻā flows between 3000 and 5000 years old
PS - mostly pāhoehoe with scrub vegetation
PF - pāhoehoe and some ʻaʻā with generally open forest or very dense scrub growth
D - highly disturbed ground
Q - old (abandoned) quarry area.

LF1 - *ʻaʻā* flow less than 3000 years old

The remnant dryland forest on LF1 is mostly one supporting *lama* (*Diospyros sandwicensis*), alaheʻe (*Psydrax odoratum*), Christmas berry, and ʻōhiʻa (*Metrosideros polymorpha*). Present, although to lesser extents; are ʻohe m*akai* (*Polyscias sandwicensis*) and hala pe*pe* (*Pleomele hawaiiensis*). Shrubs (sometimes small trees) that are relatively common are naio (*Myoporum sandwicense*), pua pilo or maiapilo (*Capparis sandwichiana*), ʻaʻaliʻi (*Dodonaea viscosa*), mamane (*Sophora chrysophylla*), and kolomona (*Senna gaudichaudii*). Very rare are uhiuhi and ʻaiea.. In the dry conditions that prevail here, the distinction between shrubs and trees is not easily made. In general, the forest is very open with low shrubs and ground-covering herbs predominate. Non-natives invasive species in this dry forest are koa haole, jacaranda (*Jacaranda mimosifolia*), and Christmas berry. The latter species seems to be particularly well suited to the habitat and consequently the most serious pest species here. The ground cover on LF1 is notably dominated by huehue (*Cocculus orbiculatus*) and koali ʻawa (*Ipomoea indica*). Fountain grass (*Pennisetum setaceaum*), lantana (*Lantana camara*), and sword fern (*Nephrolepis multiflora*) are present in scattered locations, as is koʻokoʻolau (*Bidens micrantha ctenophylla*).

LF2 - ʻaʻā flows between 3000 and 5000 years old

The somewhat older ʻaʻā flows, LF2, also support a sparse vegetation that is a mixture of native and naturalized species, but the diversity of natives is small in comparison with that on LF1 and the reasons for this are not entirely clear. Both lava flows have sparse grass cover (minimizing fire hazards) and rough terrain presumably discouraging to ungulates, such as goats.

PS - mostly pāhoehoe with scrub vegetation

The land between the lava flows (Whistler's *Leucaena* or koa haole scrub) stands out in contrast to the sparse vegetation on the ʻaʻā flows is, of course, older and mostly pāhoehoe flows. A combination of better water retention near the surface on pāhoehoe and a longer period of time for soil formation provide conditions whereby these areas support moderately dense growths of fountain grass and short koa haole as a dry shrubland. Native shrubs, especially alaheʻe and aʻaliʻi, are widely scattered within this vegetation type. At low elevations on the property, klu (*Acacia farnesiana*) appears as an occasional shrub and kiawe (*Prosopis pallida*) as a rare tree (Possibly a consequence of the long period of drought effecting this part of the Island of Hawaiʻi, nearly all of the kiawe trees observed during the 2012 survey of the project properties were deceased.) Whistler points out that because of the dense fountain grass, this scrub vegetation is subject to damaging fires, which may well have eliminated many of the native species over time.

PF - pāhoehoe and some ʻaʻā with generally open forest or very dense scrub growth

The relationship between vegetation and the nature of the substratum becomes more complex above about 600 feet on the site, and while David and Guinther (2012) designates this area as PF, it is a complex of scrub and forest vegetation types extending across the mauka or uppermost part of the property. This area is far more heterogeneous with respect to substratum age and type, and composition of the vegetation, than is the case downslope. The reasons for this are certainly related to rainfall. Rainfall records for Honokōhau Ranch nearby at 1275 feet suggest an annual rainfall of around 1230 mm (48 inches); rainfall at the old Kona Airport at 15 feet above sea level 550 mm (21.6 inches). This moisture gradient is evident in the nature of vegetation from the low end of the project area to the top end, with grasses and short stature shrubs mostly at the low end, and trees of increasing stature becoming evident above about the middle. At around the 550 to 600-foot elevation, the young lava flow is no longer clearly visible in aerial/satellite images; the forest is too dense to readily distinguish this feature from adjacent, much older surfaces. For this reason, David and Guinther (2012) lumps this vegetation under PF. However, inside a forest dominated by Christmas berry (presumably, in part, Whistler's Christmas Berry Scrub), silk oak (*Grevillea robusta*), lama, alaheʻe, and ʻōhiʻa trees are present. In the understory, either talinum (*Talinum triangulare*) or air plant (*Kalanchoë pinnata*) can be very abundant. In some places grasses are abundant, in other areas bare lava is present.

The following plant associations demonstrate the heterogeneity of the area designated as PF vegetation type, along the mauka border of the property:

Dense koa haole forest with an understory of dense Guinea grass (*Panicum maximum*) immediately off the north side of Hina Lani Street; somewhat open Christmas berry/koa haole forest with dense air plant understory merging gradually into dry land forest type (LF1), downslope and found east and west of Hina Lani Street; Christmas berry savanna with fountain grass (northeast corner of the property); koa haole scrub (cattle grazed land) with Guinea grass and scattered kukui (*Aleurites moluccana*) in the southeast corner of the property.

<u>D - highly disturbed ground & Q - old (abandoned) quarry area.</u>

Managed land vegetation corresponds to David and Guinther's (2012) vegetation on disturbed ground (ruderal vegetation), represented by the extensive verges along Hina Lani Street, other areas where the ʻaʻa flow has been graded (D), and a quarry operation (Q) in the southwest corner of the site. These places support mostly ruderal weeds and several other introduced species not observed elsewhere on the property. An exception to the near exclusively non-native aspect of disturbed areas is the presence of koʻokoʻolau along the interface between the undisturbed (LF1) and disturbed parts of the quarry. Disturbed ground is readily invaded by fountain grass. ʻUhaloa (*Waltheria indica*) is a native plant that is common in disturbed places. The now abandoned quarry area represents a part of the Kaloko-Honokōhau ʻaʻa lava flow that has been extensively graded and material removed. A few "islets" of the original surface remain where either ʻōhiʻa or maiapilo plants are growing. The site is extensively invaded by fountain grass.

Kaloko Makai Dryland Forest

The Kaloko Makai development is home to one of the largest remaining areas of Dryland Forest in the Hawaiian Islands. The Dryland Forest is located within the southern portion of the project site.

The Dryland Forest is unique in that it has not been heavily impacted by ungulates, and therefore, has minimal impact from alien plant species. The Dryland Forest covers an ʻaʻā lava flow that is much younger than the surrounding pāhoehoe flow.

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 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 ʻaʻā 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 is home to four endangered species: ʻaiea, maʻoloa*,* hala pepe and uhiuhi. The most common trees are the native species lama, alaheʻe, pua pilo and māmane. Other native trees ʻōhiʻa lehua, ʻohe, naio and ʻaʻaliʻi.

The only alien tree species noted in the Dryland Forest were jacaranda (*Jacaranda mimosifolia)*, the Polynesian introduction noni, Christmas berry, and koa haole. The latter two species, especially Christmas berry, sometimes form clumps and in some places dominate the edges of the Dryland Forest.

POTENTIAL IMPACTS AND MITIGATION MEASURES

As stated above, the Kaloko Makai property has been the subject of numerous botanical surveys over the years. Based on these surveys, the following four listed endangered and candidate plant species are found within the project site.

- ʻaiea (Nothocestrum breviflorum)
- hala pepe (Pleomele hawaiiensis)
- uhiuhi (Caesalpinia kavaiensis)
- maʻaloa (Neraudia ovata)
- koʻokoʻolau (*Bidens micrantha ctenophylla*) – Candidate

None of the listed endangered plants will be "taken" in the development and construction of the Kaloko Makai project.

Three individual endangered plants (two hala pepe and one ʻaiea) found outside the Dryland Forest Preserve will be buffered by setbacks and enclosures (fence/wall). Kaloko Makai will develop a 50-ft. radius buffer around the two hala pepe and one ʻaiea and any structure. The plants will be incorporated into landscaping within the 50-ft. buffers.

Recognizing the importance of this Dryland Forest, Kaloko Makai representatives approached the USFWS regarding the Dryland Forest and its protection.

As part of the project proposal, 150-acres will be set aside as the Kaloko Makai Dryland Forest Preserve, in Phase 1 of the project. Through the establishment of this preserve, a variety of species will have continued permanent protection and their habitat set aside, in perpetuity.

US Fish and Wildlife Service (USFWS) Proposed Rule

On October 17, 2012, the US Fish and Wildlife Service (USFWS) published a notice in the Federal Register that noted, " Endangered and Threatened Wildlife and Plants; Listing 15 Species on Hawaiʻi Island as Endangered and Designating Critical Habitat for 3 Species; Proposed Rule".

In part, the Federal Register noted, "SUMMARY: We, the U.S. Fish and Wildlife Service (Service), propose to list 15 species on the Hawaiian island of Hawaiʻi as endangered species under the Endangered Species Act of 1973, as amended (Act), and to designate critical habitat for 1 of these species. For the remaining 14 species that we are proposing to list in this rule, we find that critical habitat is not determinable at this time. We also propose to designate critical habitat for two plant species that were listed as endangered species in 1986 and 1994. The proposed critical habitat designation totals 18,766 acres (ac) (7,597 hectares (ha)), and includes both occupied and unoccupied habitat. Approximately 55 percent of the area being proposed as critical habitat is already designated as critical habitat for 42 plants and the Blackburn's sphinx moth (Manduca blackburni). In addition, we propose a taxonomic change for one endangered plant species."

It further notes, "The Secretary may exclude an area from critical habitat if the benefits of exclusion outweigh the benefits of designation, unless the exclusion will result in the extinction of the species. We are considering excluding approximately 4,102 acres of privately owned and State lands from the critical habitat designation."

One of the proposed species to be listed, *Bidens micrantha ssp. ctenophylla* (koʻokoʻolau) is found within the Kaloko Makai project area. The Federal Register notes, "*Bidens micrantha ssp. ctenophylla* (koʻokoʻolau), a perennial herb in the sunflower family (*Asteraceae*), occurs only on the island of Hawaiʻi (Ganders and Nagata 1999, pp. 271, 273). Historically, *B. micrantha ssp. ctenophylla* was known from the North Kona district, in the lowland dry ecosystem (HBMP 2010b). Currently, this subspecies is restricted to an area of less than 10 sq mi (26 sq km) on the leeward slopes of Hualalai volcano, in the lowland dry ecosystem in six occurrences totaling fewer than 1,000 individuals. The largest occurrence is found off Hina Lani Road with over 475 individuals widely dispersed throughout the area (Zimpfer 2011, in litt.). The occurrence at Kealakehe was reported to have been abundant and common in 1992, but by 2010 had declined to low numbers (Whistler 2007, pp. 1–18; Bio 2008, in litt.; HBMP 2010b; Whistler 2008, pp. 1–11). In addition, there are three individuals in Kaloko–Honokōhau National Historical Park (NHP) (Beavers 2010, in litt.), and three occurrences are found within close proximity to each other to the northeast: five individuals in an enclosure at Puʻuwaʻawaʻa Wildlife Sanctuary (HBMP 2010b); a few scattered individuals at Kaʻupulehu; and a few individuals on private land at Palani Ranch (Whistler 2007, pp. 1–18; Whistler 2008, pp. 1–11). *Bidens micrantha ssp. ctenophylla* has also been outplanted within fenced enclosures at Kaloko–Honokōhau NHP (49 individuals), Koaia Tree Sanctuary (1 individual), and Puʻuwaʻawaʻa (5 individuals) (Boston 2008, in litt.; HBMP 2010b)."

Per the proposed rules notice, "Effects of Critical Habitat Designation - Section 7 Consultation - Section 7(a)(2) of the Act, as amended, requires Federal agencies, including the Service, to ensure that actions they fund, authorize, or carry out are not likely to destroy or adversely modify critical habitat." "If a species is listed or critical habitat is designated, section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency (action agency) must enter into consultation with us."

In addition to the proposed rule, the notice addresses "Exclusions" related to critical habitat designation. It further states, "Exclusions - Application of Section 4(b)(2) of the Act Section 4(b)(2) of the Act states that the Secretary must designate or make revisions to critical habitat on the basis of the best available scientific data after taking into consideration relevant impacts, including economic and national security impacts, of specifying any particular area as critical habitat. The Secretary may exclude an area from critical habitat if he determines that the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat, unless he determines, based on the best scientific data available, that the failure to designate such area as critical habitat will result in the extinction of the species."

Specific to the Kaloko Makai property, the Federal Register notes, "Kaloko Makai Development - The Service is considering excluding 630 ac (255 ha) of habitat associated with the Kaloko Makai Development, on the western slope of Hualalai in the land divisions of Kaloko and ʻOʻoma between the elevations of 320 and 650 ft (100 and 200 m). There are three landowners with a common interest in the Kaloko Makai Development, Kaloko Properties Corporation (Figure 5–A), SCD–TSA Kaloko Makai LLC (Figure 5–B), and TSA Corporation (Figure 5–C). Two plant species included in this rule *Bidens micrantha ssp. ctenophylla* and *Mezoneuron kavaiense* are reported from this area. The area under consideration for exclusion falls within proposed critical habitat Hawaii— Lowland Dry—Unit 34, Map 106, and is comprised of, in their entirety, the areas owned by Kaloko Properties Corporation, SCD–TSA Kaloko Makai LLC, and TSA Corporation within the proposed designation".

"This unit is occupied by the plant *Bidens micrantha ssp. ctenophylla* and contains the features essential to the lowland dry ecosystem and therefore this species. This area also contains unoccupied habitat that is essential to the conservation of *Isodendrion pyrifolium* and *Mezoneuron kavaiense*."

The Federal Register notice is clear that the proposed rule is just that, a proposal. It specifically states, "our final decision may differ from this proposal." And additionally states, "In accordance with our joint policy published in the Federal Register on July 1, 1994 (59 FR 34270), we will seek the expert opinions of at least three appropriate and independent specialists regarding this proposed rule. The purpose of such review is to ensure that our proposed listing and critical habitat designation are based on scientifically sound data, assumptions, and analyses. We have posted our proposed peer review plan on our Web site at http://www.fws/pacific/informationquality/index.htm. We will invite these peer reviewers to comment, during the public comment period (see DATES), on the specific assumptions and conclusions regarding the proposed listing of 15 species and designation of critical habitat for 3 species. We will consider all comments and information we receive during the comment period on this proposed rule during our preparation of a final determination. Accordingly, our final decision may differ from this proposal."

As noted, the Federal Register publication discusses a proposed rule concerning critical habitat designation and listing of species. It specifically states that the final decision may differ from the proposal in the Federal Register. It also notes Kaloko Makai has been in discussion with USFWS concerning listed, as well as candidate species.

Kaloko Makai will continue to work with USFWS and others in addressing the forest, habitat and species issues. Given the uncertain timing and outcome of the USFWS proposal, at this time, Kaloko Makai will continue to monitor the proposed rule.

3.7. FAUNA

A Survey of Avian and Terrestrial Mammalian Species Report was prepared in September 2006 by David and Guinther to assess avian and mammalian resources within the project area. The report is included in its entirety as Appendix F.

David and Guinther conducted a follow-up study in May 2012. The survey of Avian and Terrestrial Mammalian species' purpose was to determine if there had been any significant changes in the habitats and/or Avian and Terrestrial Mammalian species' on the property since a similar survey was conducted on the site in 2006. The report is included in its entirety as Appendix G.

3.7.1 Avian Fauna

Thirty avian count stations were sited at approximately 300-meter intervals along four linear transects running from east-to-west through the project area. The transects and count stations were sited as close to those used during the course of the 2006 avian survey of the site as possible (David, 2006). A single six-minute avian point count was made at each of the 30 count stations. Field observations were made with the aid of Leica 8 X 42 binoculars and by listening for vocalizations. The counts and subsequent searches of the site, was conducted between 6:30 am and 11:00 am each morning. Time not spent counting the point count stations was used to search the remainder of the sites for species and habitats not detected during the point counts. Weather conditions were ideal, with no rain, unlimited visibility on the sites and winds of between 1 and 7 kilometers an-hour, during point count periods.

A total of 967 individual birds of 21 species, representing 12 separate families, were recorded during the station counts. Only one of the species detected during this survey, Pacific Golden-Plover (*Pluvialis fulva*) is a native species. Pacific Golden-Plover is an indigenous migratory shorebird species. One species Chicken (Red Junglefowl) [*Gallus gallus*] is a domesticated species that is not established in the wild on the Island of Hawaiʻi. The remaining 19 species detected are considered to be alien to the Hawaiian Islands (see Appendix G, Table 2).

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, 2012).

Avian diversity and densities were in keeping with the habitat present on the site and were comparable to the results of the survey conducted by David on the site in 2006. Four species, House Finch (*Carpodacus mexicanus*), Zebra Dove (*Geopelia striata*), Japanese White-eye (*Zosterops japonicus*), and Common Waxbill (*Estrilda astrild*), accounted for slightly less than 44 percent of all birds recorded during the station counts. House Finch was most frequently recorded species, accounting for 18 percent of the total number of individual birds recorded during station counts. We recorded an average of 30 birds per station count. This is a relatively large number.

Although not detected during the 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.

POTENTIAL IMPACTS AND MITIGATION MEASURES

The modification of the current habitat on the site is not expected to result in significant impacts to any avian or mammalian species. Furthermore, the development of the project site is not expected to have a significant deleterious impact on native faunal resources found within the North Kona District.

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. To reduce the potential for interactions between nocturnally flying birds with external lights and man-made structures, any external lighting that may be required in conjunction with development of the project will be shielded. This mitigation would serve the dual purpose of minimizing the threat of disorientation and downing of birds, 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.

Although there is no standing water, streams or other water features in the project area, and thus the habitat present does not support waterbirds, two listed waterbird species, the 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, and no take of these species is anticipated as a result of the development of Kaloko Makai.

3.7.2 Terrestrial Fauna

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 surveys. This mimics the same survey techniques employed during the 2006 survey of the same property (David, 2006).

Visual and electronic scans, using a Broadband AnaBat II® ultrasonic bat detector, were made for bats. The endangered ʻŌpeʻapeʻa, Hawaiian hoary bat (*Lasiurus cinereus semotus*) was not detected during the survey.

All observations of mammalian species were of an incidental nature. With the exception of the endangered ʻŌpeʻapeʻa, all terrestrial mammals currently found on the Island of Hawaiʻi are alien species, and most are ubiquitous.

Eight terrestrial mammalian species were detected during the course of this survey. European house mice (*Mus musculus domesticus*), mongooses (*Herpestes a. auropunctatus and Herpestes a. auropunctatus*), cats (*Felis catus*), a pig (*Sus s. scrofa*), and goats (*Capra h. hircus)* were seen within the study area. 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*), were encountered in several locations within the project area.

Hawaiʻi's sole endemic terrestrial mammalian species, the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), was not detected during this survey. However, during the 2006 survey 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. Thus, it is possible that Hawaiian hoary bats over-fly the general project area on a seasonal basis.

POTENTIAL IMPACTS AND MITIGATION MEASURES

The modification of the project area is not expected to result in significant impacts to any mammalian species. 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.

As previously discussed, it is possible that Hawaiian hoary bats fly-over 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.

3.7.3 Invertebrate Resources

A Survey of Terrestrial Invertebrate Resources was conducted in November 2008 by Steven Lee Montgomery, Ph.D. to assess these resources within the project area. The survey included a literature review of previous studies conducted in the general project area and field surveys of the project area which were conducted in September and October 2008. The report is included in its entirety as Appendix H.

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. Baiting is a recognized method of censusing lava tubes for cave adapted fauna. Baited traps were placed in three lava tubes from October 10 – 13, 2008.
- Host plant searches – Potential host plants, both native and introduced, were searched for arthropods that feed or rest on plants.
- Light sampling – A survey of insects active at night using a bright light source in front of a white cloth/sheet. Sampling was conducted approximately 11 hours on each night of surveying. Locations were chosen based on host plant proximity and terrain. Three of the four locations were near the native Dryland Forest.
- Seep nets – This is the 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.
- Visual observation

The Montgomery 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 statutes was located within the survey area.

Invertebrate species observed within the project area include spiders (*Araneae)*; true bugs (*Heteroptera;*, butterflies and moths (*Lepidoptera*); dragonflies and damselflies (*Odanata);* and praying mantis, grasshoppers, crickets (*Orthoptera).*

The Montgomery survey of the lava tubes yielded few native invertebrates, with a moth (*Schrankia sp*.), being the most common native species encountered. The most common arthropod encountered in the small sample of lava tubes surveyed was the adventive American cockroach (*Periplaneta Americana*). These results are not surprising given that many of the lava tubes have skylights creating a short dark zone, or none at all. 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. The major food source, long roots, supporting most lava tube arthropod communities, is mostly absent.

USFWS surveyed 25 – 30 lava tubes in 1995 and reported most caves lacked aspects recognized as necessary to support cave-adapted ecosystems.

Montgomery notes that alien predatory ants which prey on other insects 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*) are present within the project area. Ants are well documented as a primary cause of low levels of native arthropods at elevations up to 2,000 feet. Ant populations often do not overlap, have separate territories, and as a result offer very few ant-free zones to native arthropods.

The Montgomery 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, by the Montgomery survey team nor were any Lava cricket (*Caconemobius anahulu*) found on site.

The Montgomery 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 botanical survey by Whistler in 2006.

The Kaloko Makai project area includes classic habitat for centipedes, scorpions, and widow spiders.

POTENTIAL IMPACTS AND MITIGATION MEASURES

No federally or state listed endangered or threatened species were noted in the 2008 Montgomery survey. No anticipated actions related to the proposed project activity in the surveyed locations are expected to threaten an entire species.

The preservation of archaeological sites (discussed in Section 4.1) and the native Dryland Forest should assist in providing habitat for native invertebrate species.

Light is attractive to all arthropods. The potential presence of *Manduca blackburni* in the greater area makes shielded lighting an important protection for this endangered invertebrate. As discussed in 3.7 external lights will be shielded and comply with the Hawai'i County Code § 14 – 50 *et seq*.

Grading of the project area will be in compliance with the County of Hawai'i's grading ordinance requirements and will require NPDES permit from the State DOH for storm water discharges associated with construction activities, including BMPs to minimize impacts to adjacent areas. In addition, construction staging areas will be established in areas well away from sensitive areas.